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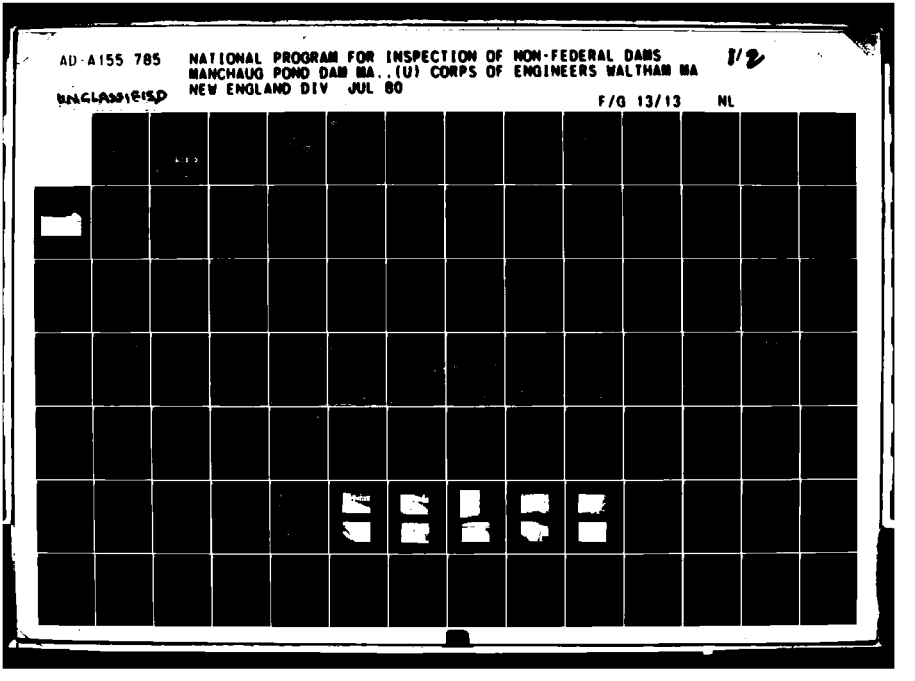

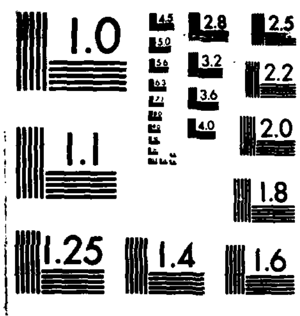

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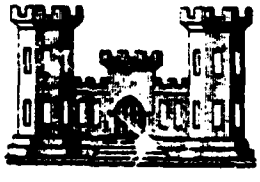
BLACKSTONE RIVER BASIN
SUTTON, MASSACHUSETTS

MANCHAUG POND DAM

MA. 00955

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

JULY 1980

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4. TITLE (and Subtitle) Manchaug Pond Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
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9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE July 1980 13. NUMBER OF PAGES 55
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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Blackstone River Basin
Sutton, Massachusetts
Unnamed Tributary to Mumford River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a composite rubble masonry and earthfill structure about 330 ft. long and 28 ft. high. The dam is judged to be in generally good physical condition. However, because of the inadequate spillway discharge capacity, it is rated in fair condition. The rubble masonry upstream face need minor repointing and the right wall of the approach channel to the spillway should be repointed. It is intermediate in size with a hazard potential of high.

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REPLY TO
ATTENTION OF:
NEDED

DEC 22 1980

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the Manchaug Pond Dam (MA-00955) Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, Mumford River Reservoir Association, Whitinsville, MA.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely,

WILLIAM E. HODGSON, JR.
Colonel, Corps of Engineers
Acting Division Engineer

Incl
As stated

MANCHAUG POND DAM

MA 00955

BLACKSTONE RIVER BASIN

SUTTON, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PORGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification NO.:	MA 00955
Name of Dam:	Manchaug Pond Dam
Town:	Sutton
County and State:	Worcester County, Massachusetts
Stream:	Unnamed Tributary to Mumford River
Date of Inspection:	15 April and 20 May 1980

BRIEF ASSESSMENT

Manchaug Pond Dam is a composite rubble masonry and earthfill structure about 330 ft. long and 28 ft. high. The original dam was reconstructed and raised in 1960. The dam's upstream face is of stepped, rubble masonry construction and is the only exposed portion of the original dam. When the dam was reconstructed an earthfill was placed over an existing downstream stone wall and the downstream face now has a slope of 2 horizontal to 1 vertical. The crest width of the dam is 36 ft. and Torrey Road passes over the dam along its crest. The spillway for the dam is a concrete box culvert. The culvert is 9.35 ft. high and has a crest length of 10.0 ft. at its entrance. There is a low level outlet for the dam near the right abutment which is controlled by an upstream sluice gate. The dam is used to store process and cooling water for mills located downstream on the Mumford River and the pond is also used for recreation.

The pond is about 8,000 ft. long and has a surface area at spillway crest level of about 350 acres. The drainage area above the dam is about 6.6 sq. mi. (4,212 acres) and the maximum storage to top of dam is about 6,850 acre-ft. Based on height and storage the size classification is intermediate. A breach of the dam would damage at least ten homes, three public buildings, a mill complex, and three local roadways in the initial impact area; therefore, the dam has been classified as having a high hazard potential. Based upon the guidelines, the recommended test flood is a full PMF. The test flood inflow was calculated to be 9,700 cfs.

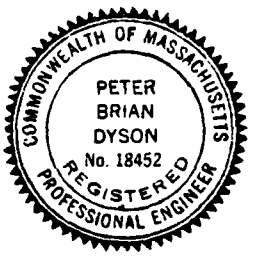
The routed test flood outflow of 3,400 cfs would overtop the dam by about 2.0 ft. The spillway can pass about 880 cfs or 26 percent of the routed test flood outflow without overtopping the dam.

The dam is judged to be in generally good physical condition. However, because of the inadequate spillway discharge capacity, it is rated in fair condition. The rubble masonry upstream face needs minor repointing and the right wall of the approach channel to the spillway should be repointed.

Within one year after receipt of this Phase I Inspection Report, the owner, the Mumford River Reservoir Association, should retain the services of a registered professional engineer, experienced in the design of dams, to make further investigations of the following, and should implement the results: (1) perform a detailed hydraulic and hydrologic analysis to further assess the need for and means to increase the project discharge capacity; (2) inspect the inside of the box culvert spillway during a period of low flow or no flow conditions and determine whether repairs are needed.

The owner should also implement the following operating and maintenance measures: (1) repair minor spalling of the mortared joints of the upstream rubble masonry wall by repointing with mortar; (2) repair voids in the rubble masonry wall of the spillway approach channel on the right side by repointing with mortar; (3) monitor seepage emanating from the 6 in. asphalt coated corrugated metal pipe at the toe of the dam and to the left of the spillway outlet to ascertain any changes in clarity and quantity of flow; (4) develop a formal surveillance and downstream emergency warning plan including round-the-clock monitoring during periods of heavy precipitation; (5) continue to conduct annual technical inspections of the dam and its appurtenant structures; (6) implement a regular periodic maintenance program.

Peter B. Dyson
Project Manager



This Phase I Inspection Report on Manchaug Pond Dam (MA-00955) has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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SECTION 5 - EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General

Manchaug Pond Dam consists of an earth embankment constructed over an original earth and masonry dam. The dam impounds a normal storage of about 2,500 acre-ft. and has provisions for an additional 4,350 acre-ft. of storage in its surcharge space to the top of dam. It is basically a high surcharge - low spillage facility used for recreational purposes and for the storage of water for industrial use by mills located downstream of the dam. The spillway for the facility is a concrete box culvert and there are provisions for a stoplog in the approach channel to the spillway. With the stoplog removed the spillway is capable of discharging about 880 cfs with the surcharge to the top of dam. With the stoplog in place the spillway capacity is reduced by about 90 cfs when the surcharge is at top of dam. The general topographic characteristics of the 6.58 sq. mi. (4,212 acres) drainage basin is best described as rolling terrain, which rises from elevation 516 at spillway crest level to elevation 890. The area contains both open fields and forested areas but is predominately forested. The area has scattered population with the highest concentration of houses being located along the rim of the pond.

5.2 Design Data

Only a limited amount of hydrologic or hydraulic design data were disclosed for Manchaug Pond Dam. The recovered data consists of a listing of the watershed area, pond area, and storage capacity for the facility. This data is shown in Appendix B and is in close agreement with the figures computed for this report.

5.3 Experience Data

No records are available in regard to past operation of the facility, nor of surcharge encroachments and flows through the spillway. The maximum past inflows are unknown.

5.4 Test Flood Analysis

Hydrologic and hydraulic characteristics of Manchaug Pond Dam and drainage area were evaluated in accordance with the criteria given in Recommended Guidelines for Safety Inspection of Dams. As indicated in Section 1.2, paragraph c and d, Manchaug Pond Dam is classified as intermediate in size and has a high hazard potential. The recommended test flood for hydraulic evaluation of such a dam is a full PMF.

Precipitation data were obtained from Hydrometerological Report No.33, which for this area of Massachusetts approximates 23.5 in. of maximum rainfall over a 10 square mile area. This value was then reduced by 20 percent to allow for basin size, shape and fit factors, an additional 0.4 in. was deducted for infiltration losses. The six hour rainfall was distributed into one hour incremental periods as suggested in Corps of Engineers Publication EC 11110-2-1411.

SECTION 4 - OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operation Procedures

a. General. The dam is owned and operated by the Mumford River Reservoir Association. It is operated in conjunction with several other bodies of water to supply cooling water and a small amount of process water for mills located downstream of the dam. Manchaug Pond is also used as a recreational facility by property owners located along the shoreline. In the fall the reservoir is said to be drawn down to allow shoreline property owners to make repairs to boat docks and other recreational facilities.

b. Description of any Warning System in Effect. No warning system is in effect at Manchaug Pond Dam.

4.2 Maintenance Procedures

a. General. There is no documented regular maintenance program in effect at Manchaug Pond Dam. There are, however, several items which require periodic maintenance, such as: the removal of debris from the spillway facilities; the repair of the upstream rubble masonry wall; the maintenance of the grass on the downstream slope; the repair of the walls to the spillway approach channel; surveillance of the downstream embankment regarding seeps; and, maintenance of the outlet facility.

b. Operating Facilities. The only operating facilities for the dam are a hand operated low level outlet and a stoplog facility in the spillway approach channel. Maintenance of these facilities is said to be performed as required.

4.3 Evaluation

Overall maintenance of the dam is generally good. Specific maintenance items are evaluated as follows: the control mechanism for the low level outlet and the stoplog structure in the approach channel to the spillway appear to be in good condition; the spillway was clear of debris; the downstream embankment has a good cover of grass and appears to be well maintained; repointing is required at some locations in the upstream rubble masonry wall and along the training wall of the spillway approach channel. A regular periodic maintenance program should be implemented. The owner should establish a formal warning system for the dam in the event of an emergency.

joints of the upstream rubble masonry wall, the minor seepage issuing through the rubble masonry spillway approach channel wall and the need to monitor the seepage at what appears to be a toe drain outlet pipe just to the left of the spillway outlet. At the time of the inspection, high flows through the spillway prevented inspection of the inside of the spillway structure. There is no regular periodic maintenance program.

the downstream slope of the dam (see Phote No. 5).Photo No. 6 shows the spillway entrance in the background with the low level outlet control structure in the far background. Photo No. 7 is a view of the outlet end of the spillway. The approach channel to the spillway is formed by the remains of the original dam and is about 10 ft. long and has vertical sides with a variable height. A 2.4 ft. high stoplog was set in the approach channel stoplog structure at the time of the inspection. Photo No. 8 shows a view of the stoplog structure. The photo also shows seepage emanating from the old rubble masonry wall where it intersects with the newer concrete part of the spillway. During the structural inspection of the spillway it was not possible to view the interior of the culvert because of the flows through the spillway. The structure appears to be in good condition. However, the inside surfaces of the culvert should be inspected under low or no flow conditions (see section 7.2).

The low level outlet for the dam is located about 80 ft. from the right abutment. The outlet is a stone box conduit about 45 ft. long which transitions to a concrete box conduit about 60 ft. long. The stone box, conduit is 2 ft. square and is part of the original dam. The concrete box is 2 ft. wide by 3 ft. high and was added to the facility when the dam was reconstructed in 1960. Photo No. 9 is a view of the outlet end of the conduit. The conduit shows minor pitting of the surface of the concrete but is generally in good condition. The control mechanism for the facility is a hand operated sluice gate on the inlet end of the conduit. A chainlink fence with locked gate surrounds the control mechanism. The sluice gate was not operated during the inspection but was reported to be in good condition. The outlet channel at the downstream end of the conduit is protected with randomly placed stone and is in good condition.

d. Reservoir Area. The shores of the reservoir are moderately to steeply sloped, mostly wooded, and dotted with camps and houses. The shoreline at the right and left abutments appears stable with no evidence of sloughing or major distress.

e. Downstream Channel. The spillway discharges into a short manmade trapezoidal channel with a 15 ft. base and then into a natural unnamed stream (see Photo No. 10). About 1,000 ft. below the dam, flows enter Stevens Pond which has several camps located around its rim. At the outlet end of Stevens Pond there is another dam. About 500 ft. below the Stevens Pond Dam the stream joins Dark Brook to form the Mumford River. About 1,000 ft. further downstream is the Village of Manchaug where another dam is located in the center of the Village. Beyond Manchaug the river flows through a series of run-of-the-river impoundments and several villages before reaching the Blackstone River about 13 miles below the dam.

3.2 Evaluation

The visual inspection adequately revealed key characteristics of the dam as they may relate to its stability and integrity. The dam and appurtenant works were judged to be in good physical condition. The only items of concern are the very minor spalling of the mortared

SECTION 3 - VISUAL INSPECTION

3.1 Findings

a. General. The visual inspection of Manchaug Pond Dam took place on 15 April and 20 May 1980. On 15 April the water level was about 1.1 ft. above the top of the 2.4 ft. high stoplog in the spillway approach channel and the discharge through the spillway was estimated to be about 35 cfs. On 20 May the water level was below the top of the stoplog and water was flowing through the low level outlet. There was not evidence of any major problems, but a few items require attention. In general, the physical condition of the dam was judged to be good.

b. Dam. Manchaug Pond Dam is a composite stone masonry and earthfill dam about 330 ft. long and 28 ft. high. The dam was reconstructed in 1960, it was raised about 4 ft., the crest was widened from approximately 28 ft. to 36 ft. and a compacted earthfill having a slope of 2 horizontal to 1 vertical was placed over the existing downstream rubble masonry walls. Part of the original dam is still exposed and serves as the upstream face of the reconstructed dam. The upstream slope is a stepped, rubble masonry wall with mortared joints consisting of a gravity section and a paved stone sloping section as shown in Photo No. 1. The upstream rubble masonry wall is in need of some repointing. Photo No. 2 shows a typical void in the wall at a point about 50 ft. left of the spillway, the total amount of repointing required appears to be small.

The dam embankment also serves to support Torrey Road which is located on the crest and passes along the entire length of the dam. The profile of the roadway is a sagging vertical curve as it crosses the dam and its low point is located near the midpoint of the dam directly above the box culvert which serves as the spillway for the facility. The alignment of the crest of the dam appears good with no indications of movement or bulges.

Photo No. 3 is a view of the downstream slope of the earthfill embankment taken from the left abutment. The alignment of the downstream slope is good. The embankment is grass covered and appears to be well maintained. At the toe of the dam just left of the spillway outlet there is a 6 in. asphalt coated corrugated metal pipe that was issuing on 20 May 1980 approximately one gallon per minute of clean water as shown in Photo No. 4. This pipe appears to be a toe drain outlet which should be monitored for changes in volume and clarity.

c. Appurtenances. The spillway for the facility is located near midpoint of the dam. It is a concrete box culvert about 97 ft. long. At the entrance the culvert is 9.35 ft. high and has a crest length of 10 ft. As the culvert passes under the crest of the dam its roof serves to support Torrey Road. The roof of the culvert is exposed along

SECTION 2 - ENGINEERING DATA

2.1 Design Data

No data on the design of the original nineteenth century dam appears to exist. The 1960 reconstruction of the dam was designed by Green Affiliates, Inc. of Boston, Massachusetts. Copies of drawings showing the proposed reconstruction are included in Appendix B.

2.2 Construction Data

No records or correspondence have been found regarding construction data, with the exception of an inspection report which states that the dam was revamped in 1960.

2.3 Operation Data

No engineering operational data were disclosed.

2.4 Evaluation of Data

a. Availability. There was limited engineering data available. The basis of the evaluation presented in this report is principally the visual observations of the inspection team.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

c. Validity. Not applicable.

g. Dam

(1) Type - Composite-earth embankment over stone masonry

(2) Length - 330 ft.

(3) Height - 28 ft.

(4) Top Width - 36 ft.

(5) Side Slopes - Upstream-stepped stone, slope unknown
Downstream - earth, 2 horizontal to 1 vertical

(6) Zoning - Unknown

(7) Impervious Core - Unknown

(8) Cutoff - Unknown

(9) Grout curtain - Unknown

h. Diversion and Regulating Tunnel - Not applicable

i. Spillway

(1) Type - Concrete box culvert

(2) Length of weir - 10 ft.

(3) Crest elevation with stoplog - 518.3, without stoplog - 515.9

(4) Gates - None

(5) U/S Channel - 10 ft. long x 10 ft. wide stone approach

(6) D/S Channel - Natural Channel

(7) General - Box culvert is 9.35 ft. high x 10 ft. wide

j. Regulating Outlets

(1) Invert - 503.7

(2) Size - 2 ft. x 2 ft. upstream transitions to 2 ft. wide x 3 ft. high downstream

(3) Description - Stone box upstream transitions to concrete box downstream

(4) Control Mechanism - Hand operated sluicegate.

c. Elevation (ft. N.G.V.D.)

(1) Streambed at toe of dam - 498.5

(2) Bottom of cutoff - unknown

(3) Maximum tailwater - unknown

(4) Normal pool - 515.9

(5) Full flood control pool - Not applicable

(6) Spillway crest - 515.9

(7) Design surcharge (Original Design) - Unknown

(8) Top of dam - 526.75

(9) Test flood surcharge - 528.7

d. Reservoir (Length in feet)

(1) Normal pool - 8,300

(2) Flood control pool - Not applicable

(3) Spillway crest pool - 8,300

(4) Top of dam - 8,900

(5) Test flood pool - 8,900

e. Storage (acre-feet)

(1) Normal pool - 2,500

(2) Flood control pool - Not applicable

(3) Spillway crest pool - 2,500

(4) Top of dam - 6,850

(5) Test flood pool - 7,750

f. Reservoir Surface (acres)

(1) Normal pool - 349

(2) Flood-control pool - Not applicable

(3) Spillway crest - 349

(4) Top of dam - 437

(5) Test flood pool - 473

1.3 Pertinent Data

a. Drainage Area. The drainage area contributing to Manchaug Pond is situated at the head waters of an unnamed stream which is a tributary of the Mumford River. The drainage area encompasses a total of about 6.58 sq. mi. (4,212 acres), of which 349 acres are occupied by the reservoir. The longest circuitous waterway course leading to the dam is about 4.0 miles long with an elevation difference of about 158 ft., or at a slope of about 29 ft./mi. The drainage area has a length of about 3.2 miles and an average width of about 2.1 miles. The basin consists of both open fields and forested areas and is sparsely populated. Most of the population is concentrated along the shores of the pond. There are no other significant bodies of water in the drainage area.

b. Discharge at Damsite

(1) Outlet Works Conduit. Low level discharge from Manchaug Pond is provided for by means of a stone box conduit that is 2 ft. square which transitions to a 2 ft. wide by 3 ft. high concrete conduit as it passes through the dam. The outlet of the conduit has an invert elevation of approximately 503.7 ft. The conduit would be capable of discharging about 100 cfs when the gate is wide open and the pond water surface was at the top of dam, elevation 526.75.

(2) Maximum Known Flood at Damsite. No records are available of flood inflows into Manchaug Pond, nor of spillway releases and surcharge heads during such inflows.

(3) Ungated Spillay Capacity at Top of Dam. The total spillway capacity at top of dam without the stoplog in place is about 880 cfs at elevation 526.75 ft. With the 2.4 ft. high stoplog in place the spillway capacity would be reduced to about 790 cfs when the water surface was at top of dam elevation 526.75.

(4) Ungated Spillway Capacity at Test Flood Elevation. The ungated spillway capacity is 1,100 cfs at test flood elevation 528.7 ft.

(5) Gated Spillway Capacity at Normal Pool Elevation. Not Applicable

(6) Gated Spillway Capacity at Test Flood Elevation. Not applicable

(7) Total Spillway Capacity at Test Flood Elevation. The total spillway capacity at the test flood elevation is the same as (4) above, 1,100 cfs at elevation 528.7.

(8) Total Project Discharge at Top of Dam. With the stoplog removed and the low level discharge open the total project discharge is about 980 cfs at top of dam, elevation 526.75 ft.

(9) Total Project Discharge at Test Flood Elevation. The total project discharge at test flood elevation, 528.7 ft. is about 3,400 cfs.

d. Hazard Classification. A breach failure of Manchaug Pond Dam would release water down an unnamed brook to Stevens Pond and thence to the Mumford River. It is estimated that in the initial impact area flooding would occur and that the Stevens Pond Dam and a dam in Manchaug Village would be overtopped. It is also estimated that at least ten houses, a mill complex, a fire station, and a library would be flooded by depths of water ranging from 3 to 6 ft. In the village, the post office and another building would probably sustain minor flooding as would three or four camp sites located on Stevens Pond. Three roadways in the initial impact area would also sustain flooding. No significant flooding is anticipated when the spillway is flowing full. In accordance with the Recommended Guidelines for Safety Inspection of Dams, Manchaug Pond Dam has therefore been classified as having a high hazard potential, since failure may cause serious damage to more than a small number of habitable structures and extensive community and industrial economic loss, with the potential for the loss of more than a few lives.

e. Ownership. Manchaug Pond Dam is owned by the Mumford River Reservoir Association, c/o Mr. Joseph Rosol, ATF Davidson Co., Main St. Whitinsville, Mass. 01588. Telephone: 617-234-7451.

f. Operator. Mr. Joseph Rosol, c/o ATF Davidson Co., Main St. Whitinsville, Mass. 01588. Telephone: 617-234-7451.

g. Purpose of Dam. The dam impounds a reservoir used for recreational purposes. Also, the dam still serves its original purpose of supplying the water needs of mills located downstream on the Mumford River.

h. Design and Construction History. It is not known by whom the original dam was designed and constructed. It is believed the original dam was built in 1836 to meet the water demands of mills located downstream on the Mumford River. The original dam was reconstructed in 1960. At that time the dam was raised by about 4 ft. and widened by about 8 ft. A 2 horizontal to 1 vertical earth embankment was added on the downstream side of the dam. A new spillway was constructed during the same period and the low level outlet conduit was extended.

The work performed in 1960 was initiated by the Massachusetts Department of Public Works, Division of Waterways, as a flood control measure. The design for the reconstruction of the dam was performed by Green Engineering Affilates, Inc. of Boston, Massachusetts. Since 1960 the chainlink fences have been placed around both the spillway stoplog structure and the low level outlet control structure.

i. Normal Operating Procedures. No written operating procedures for the dam were disclosed. According to the owner's representative, the low level outlet sluice gate is operated from time to time and the reservoir is drawn down in the fall in anticipation of spring runoff and for the benefit of property owners located along the rim of the reservoir.

The downstream face of the original dam was also of stone construction, but it was completely covered during the reconstruction. The new 2 horizontal to 1 vertical downstream slope is grass covered.

The embankment also serves to support Torrey Road which is located along the crest for the entire length of the dam. The profile of the roadway is a sagging vertical curve as it crosses the dam, with its low point located near midpoint of the dam directly above the concrete box culvert which serves as the spillway for the facility. The dam has a crest width of about 36 ft. The crest is paved with a bituminous material and bituminous berms are constructed along the edge of the roadway.

(2) Spillway. The spillway for Manchaug Pond Dam is located near midpoint of the dam. It is a concrete box culvert about 97 ft. long. At its entrance the spillway culvert is 9.35 ft. high and has a crest length of 10 ft. As the culvert passes under the crest of the dam, its roof serves to support Torrey Road. The roof of the culvert is exposed along the downstream slope of the dam.A plan showing the spillway in plan and profile views can be found in Appendix B.

The approach channel to the spillway culvert is formed by the remains of the original dam and is about 10 ft. long. A stoplog facility is located in the approach channel about 5 ft. upstream from the spillway culvert entrance. The facility has provisions for a 2.4 ft. high stoplog. A vertical steel rod extends from the stoplog for removal purposes. A small steel access bridge spans the approach channel and stoplog structure, the access bridge is enclosed by a chainlink fence which is gated and locked.

(3) Low Level Outlet. The low level outlet for Manchaug Pond Dam is located about 80 ft. from the right abutment of the dam. The outlet is a stone box conduit about 45 ft. long which transitions to a concrete box conduit about 60 ft. long. The stone box conduit is 2 ft. square and is part of the original dam. The concrete box conduit is 2 ft. wide by 3 ft. high and was added to the facility when the dam was reconstructed in 1960. The control mechanism for the low level outlet is a hand operated sluice gate located at the inlet end of the conduit. A small steel platform and chainlink fence surround the control mechanism. The low level conduit outlets at the toe of the dam into a stone lined channel which leads to the spillway discharge channel about 120 ft. below the dam.

(c) Size Classification. Manchaug Pond Dam has a hydraulic height of about 28 ft. above downstream river level, and impounds a normal storage of about 2,500 acre-ft. to spillway crest level and a maximum of about 6,850 acre-ft to top of dam. In accordance with the size and capacity criteria given in Recommended Guidelines for Safety Inspection of Dams, the project falls into the intermediate category on the basis of height and capacity and is therefore classified accordingly.

PHASE I INSPECTION REPORT

MANCHAUG POND MA 00955

SECTION I - PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Louis Berger & Associates, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Louis Berger & Associates, Inc. under a letter of 28 March 1980 from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C-0043,has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

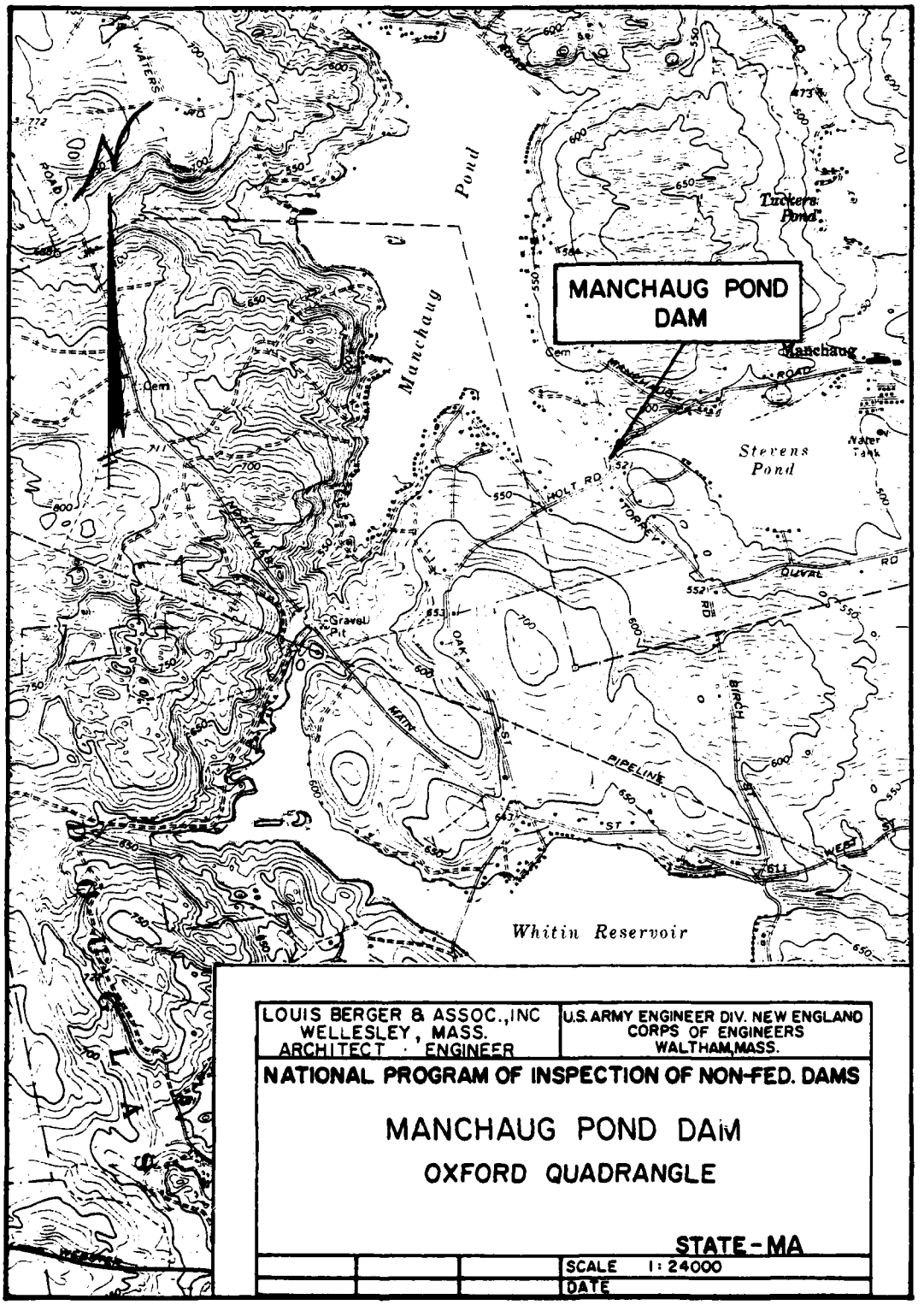
(3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

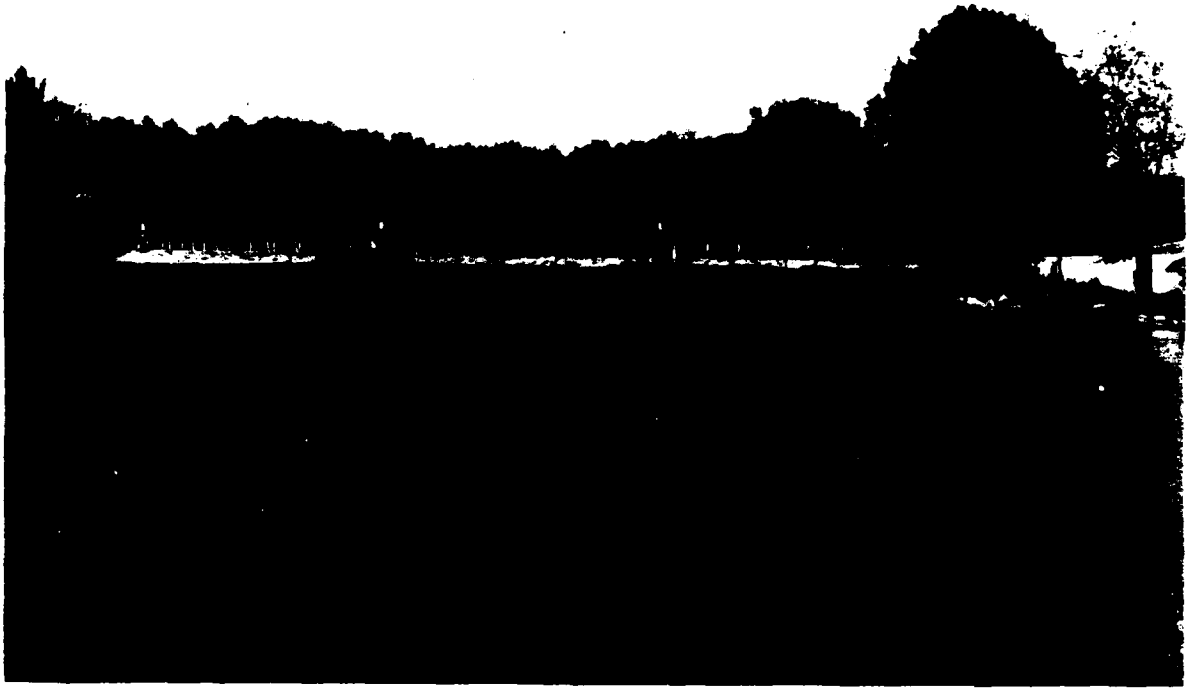
a. Location. Manchaug Pond Dam is located in Worcester County, in the Town of Sutton in south-central Massachusetts. The Pond is situated on an unnamed stream approximately one mile upstream from where the stream joins Dark Brook to form the Mumford River. Torrey Road passes along the crest of the dam. The dam is shown on U.S.G.S. Quadrangle, Oxford, Mass. - Conn. - R.I. with coordinates approximately at N 42° 05' 25" at W 71° 46' 02".

b. Description of Dam and Appurtenances

(1) Description of Dam. Manchaug Pond Dam is a composite masonry and earthfill structure about 28 ft. high and 330 ft. long. The original dam was reconstructed and raised in 1960. Remains of the older dam still appear on the upstream side and form the upstream face of the structure, which is of stepped stone construction with mortared joints.


MANCHAUG POND DAM
Manchaug Pond
Tuckers Pond
Stevens Pond
Whitin Reservoir
Manchaug
Gravel Pit
HOLT RD
OLIVAL RD
PIPELINE
WATERS ROAD
MANCHAUG ROAD
OAK ST
BIRCH ST
MAPLE ST
WEBB ST
Dam
LOUIS BERGER & ASSOC., INC
WELLESLEY, MASS.
ARCHITECT · ENGINEER
U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
MANCHAUG POND DAM
OXFORD QUADRANGLE
STATE - MA
SCALE 1:24000
DATE

MANCHAUG POND DAM



OVERVIEW OF DAM

A triangular incremental unitgraph was assumed for the inflow hydrograph using a computed lag time of 5.45 hours to derive a time-to-peak for the triangular hydrograph of 4.88 hours (see computations on Sheets D-8 and D-9, Appendix D), indicating a peak inflow of about 9,700 cfs or a CSM value of about 1,470.

For determining surcharge areas and surcharge capacities planimetered areas were taken from contours delineated on U.S.G.S. 1:24,000 quadrangle sheets. Discharge tables and curves for the spillway and for over the top of the dam are shown on Sheets D-5 thru D-7, Appendix D. The discharge curve has been computed assuming no stoplog in place. Also, it was assumed that there was no flow through the low level outlet during the test flood.

Flood routings were performed for both the test flood and a ½PMF. Graphical solutions were used for routing the floods through the reservoir and are shown on Sheets D-12 and D-13, Appendix D. The results are summarized below.

Flood Magnitude	Test Flood Inflow (cfs)	Maximum Res. El. (ft. NGVD)	Maximum Head Over Dam (ft.)	Routed Test Flood Outflow (cfs)
PMF (Test Flood)	9,700	528.7	2.0	3,400
½PMF	4,850	523.4	None	500

From the above table, it can be seen that the project will not pass the routed test flood outflow without overtopping the dam by about two feet. The project, however, can handle about 26 percent of the routed test flood without overtopping the dam.

5.5 Dam Failure Analysis

A breach owing to structural failure of the dam by piping or sloughing is a possibility. For this analysis a breach was assumed to occur with the water level at top of dam. The "rule of thumb" method suggested in the NED March 1978 Guidance Report was used for the breach analysis. With a breach width of 40 percent of the dam length at mid-height equal to about 96 ft., an outflow of about 25,000 cfs, which includes 880 cfs from the spillway, would be realized, (see Sheets D-14 thru D-19, Appendix D).

About 1,000 ft. below Manchaug Pond Dam is located Stevens Pond Dam. It is estimated that the breach discharge would overtop the Stevens Pond Dam as the water would rise about 7.5 ft. higher than that stage due only to the spillway discharge. However, an inspection of the shoreline of Stevens Pond indicates that only three or four camps located along the rim of the pond would be affected by this high water and that the extent of flooding would only be about 1 or 2 ft. No flooding would occur in this area due to the spillway discharge alone.

About one mile below Manchaug Pond Dam the unnamed stream from Manchaug Pond joins Dark Brook to form the Mumford River. About 1000 ft. further downstream, in the Village of Manchaug, the breach of the dam will cause a significant impact. It is estimated that the breach discharge will be about 21,000 cfs in this area and that a fire station, a library, a large mill complex, and at least ten houses would be flooded by depths of water ranging from 3 to 6 ft. It is also estimated that a post office building and another building will sustain flooding to a lesser extent. There are also three local roadways in this area of initial impact which would be flooded and probably seriously damaged. It is estimated that the river stage due to the spillway discharge alone would not cause any significant flooding in this area.

In summary, in the area of initial impact there are more than a small number of habitable structures which would be significantly flooded and there is the potential for loss of life because of the breach. Therefore in accordance with the Recommended Guidelines for Safety Inspection of Dams, this project is classified as a high hazard potential. Appendix D, Sheet D-20, shows the area of potential flooding described above.

SECTION 6 - EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The Manchaug Dam is in good condition as revealed by the field inspections of April 15 and May 20, 1980. However, there are a few items of a remedial nature which were observed and which require treatment as outlined in section 7 of this report. The items requiring remedial treatment are the minor spalling of the mortared joints in the upstream masonry rubble wall, the minor seepage entering through the right side of the inlet to the spillway concrete outlet structure where it intersects the rubble masonry retaining wall and the need to monitor seepage at the corrugated metal pipe adjacent to the left side of the spillway outlet structure at its downstream end.

6.2 Design and Construction Data

A general layout plan and typical cross-sections of the Manchaug Pond Dam prepared by Green Engineering Affiliates, Inc. of Boston, Massachusetts is contained in the appendix. The dam was modified in 1960. The dam originally consisted of an earth filled section retained by masonry rubble gravity walls. The 1960 modifications are described below.

6.3 Post-Construction Changes

Major modifications were made to the embankment and spillway in 1960. These modifications were as follows:

1) The crest elevation was raised about 4 ft.

2) The crest was widened by approximately 8 ft. and compacted earth embankment having a slope of 2 horizontal to 1 vertical was placed over the downstream rubble masonry wall. The parapet portion of the downstream rubble masonry wall was removed.

3) A new concrete spillway was constructed to replace the previous spillway which was removed.

Further details of these major modifications are shown on the design drawings in Appendix B.

6.4 Seismic Stability

The dam is located in Seismic Zone #2 and in accordance with recommended Phase I guidelines does not warrant seismic analysis.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. On the basis of the Phase I visual examination, Manchaug Pond Dam is judged to be in good physical condition, but because of the inadequate spillway discharge capacity it is rated as in fair condition. A further investigation should be carried out and some remedial work is needed. The major concern revealed by the Phase I investigation is that the spillway will only pass 26 percent of the routed test flood outflow.

b. Adequacy of Information The lack of in-depth enginering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgement.

c. Urgency The recommendations and remedial measures enumerated below should be implemented by the owner within one year after receipt of this Phase I Inspection Report.

7.2 Recommendations

It is recommended that the owner, the Mumford River Association, should retain the services of a registered professional engineer experienced in the design of dams to make further investigations of the following, and should implement the results:

(1) Perform a detailed hydraulic and hydrologic analysis to further assess the need for and means to increase theproject discharge capacity.

(2) Inspect the inside of the box culvert spillway during a period of low flow or no flow conditions and determine whether repairs are needed.

7.3 Remedial Measures

(a) Operating and Maintenance Procedures

(1) Repair minor spalling of the mortared joints of the upstream masonry rubble wall by repointing with mortar.

(2) Repair voids in the rubble masonry wall at the spillway approach channel on the right side by repointing with mortar.

(3) Monitor seepage emanating from the 6 in. diameter asphalt coated corrugated metal pipe at the toe of the dam and to the left of the spillway outlet to ascertain any changes in clarity and quantity of flow.

(4) Develop an "Emergency Action Plan" that will include an effective preplanned downstream warning system, locations of emergency equipment, materials and manpower, authorities to contact and potential areas that require evacuation. The plan will also include round-the-clock monitoring of the project during periods of heavy precipitation.

(5) Continue to conduct annual technical inspections of the dam and its appurtenant structures.

(6) Implement a regular periodic maintenance program.

7.4 Alternatives

There are no feasible alternatives to the above recommendations.

Appendix A

Inspection Checklist

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Manchaug Pond Dam DATE 15 April and 20 May 1980

OWNER Mumford River Reservoir TIME 9:30 AM

WEATHER 15 Apr Clear/Cool
~~20 May Clear/Cool~~

W.S. ELEV. 519.4 U.S. NA DN.S.

INSPECTION PARTY

PARTY: A/E Representatives	Owner's Representatives
1. Peter B. Dyson	6. Joseph Rosol
2. Pasquale E. Corsetti	7. Carl Feraco
3. Roger F. Berry	8. Delwyn K. Barnes
4. Carl J. Hoffman	9.
5. William S. Zoino	10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Hydrologic	Roger F. Berry	LBA
2.	Hydraulics/Structures	Carl J. Hoffman	LBA
3.	Soils and Geology	William S. Zoino	GZA
4.	General Features	Peter B. Dyson	LBA
5.	General Features	Pasquale E. Corsetti	LBA
6.			
7.			
8.			
9.			
10.			

LBA - Louis Berger & Associates, Inc.
GZA - Goldberg-Zoins & Associates, Inc.

PERIODIC INSPECTION CHECKLIST

PROJECT Manchaug Pond Dam DATE 20 May 1980

PROJECT FEATURE Dam Embankment NAME

DISCIPLINE Soils/Geology NAME William S. Zoino

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	526.75
Current Pool Elevation	Not Recorded
Maximum Impoundment to Date	Unknown
Surface Cracks	None
Pavement Condition	Good-Minor sporadic cracking in Asphalt paving
Movement or Settlement of Crest	Negligible - about ½" between embankment and outlet structure
Lateral Movement	None
Vertical Alginment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	Good
Trespassing on Slopes	Negligible
Sloughing or Erosion of Slopes or Abutments	None
Rock Slope Protection - Riprap Failures	None
Unusual Movement or Cracking at or near Toes	None
Unusual Embankment or Downstream Seepage	About 1 GPM clear water from toe drain outlet
Piping or Boils	
Foundation Drainage Features	None
Toe Drains	Good
Instrumentation System	N/A

PERIODIC INSPECTION CHECKLIST

PROJECT Manchaug Pond Dam DATE 15 April 1980

PROJECT FEATURE Intake Structure NAME

DISCIPLINE Structural NAME Carl J. Hoffman

AREA EVALUATED	CONDITIONS
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	None
Slope Conditions	N/A
Bottom Conditions	N/A
Rock Slides or Falls	N/A
Log Boom	N/A
Debris	N/A
Condition of Concrete Lining	N/A
Drains or Weep Holes	N/A
b. Intake Structure	Stone Masonry and Steel Structure
Condition of Concrete	Good
Stop Logs and Slots	N/A

PERIODIC INSPECTION CHECKLIST

PROJECT Manchaug Pond Dam DATE 15 April 1980

PROJECT FEATURE Conduit NAME

DISCIPLINE Structures NAME Carl J. Hoffman

AREA EVALUATED	CONDITIONS
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	Good
Rust or Staining on Concrete	None
Spalling	Minor spalling at outlet end
Erosion or Cavitation	None visible
Cracking	None visible
Alignment of Monoliths	N/A
Alignment of Joints	N/A
Numbering of Monoliths	N/A

PERIODIC INSPECTION CHECKLIST

PROJECT Manchaug Pond Dam DATE 15 April 1980

PROJECT FEATURE Spillway NAME

DISCIPLINE Hydraulics/Structures NAME Carl J. Hoffman

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	Stone Masonry Channel
General Condition	Fair - Minor spalling of mortar and some leakage through right wall
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	None Visible
b. Weir and Training Walls	
General Condition of Concrete	Good*
Rust or Staining	None
Spalling	None
Any Visible Reinforcing	None
Any Seepage or Efflorescence	None Visible
Drain Holes	None Visible
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Channel	Good
Other Obstructions	None

* Spillway is a Box Culvert which was not observed from the interior

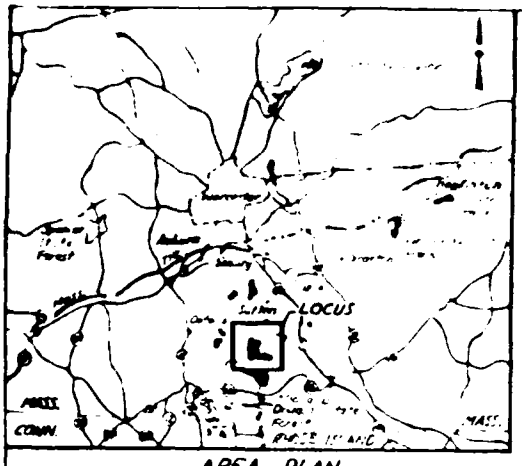
PERIODIC INSPECTION CHECKLIST

PROJECT: Manchaug Pond Dam **DATE:** 15 April 1980

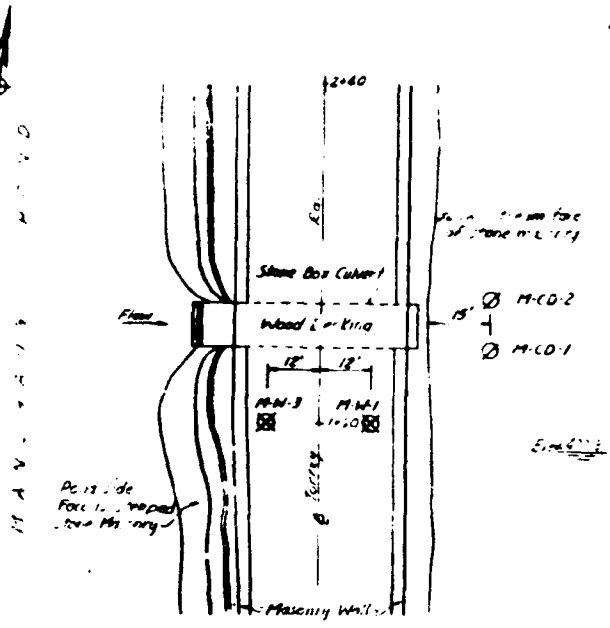
AREA EVALUATED	CONDITIONS
Dike Embankment	N.A.
Outlet Works - Control Tower	N.A.
Outlet Works - Outlet Structure and Outlet Channel	N.A.
Outlet Works - Service Bridge	N.A.

Appendix B

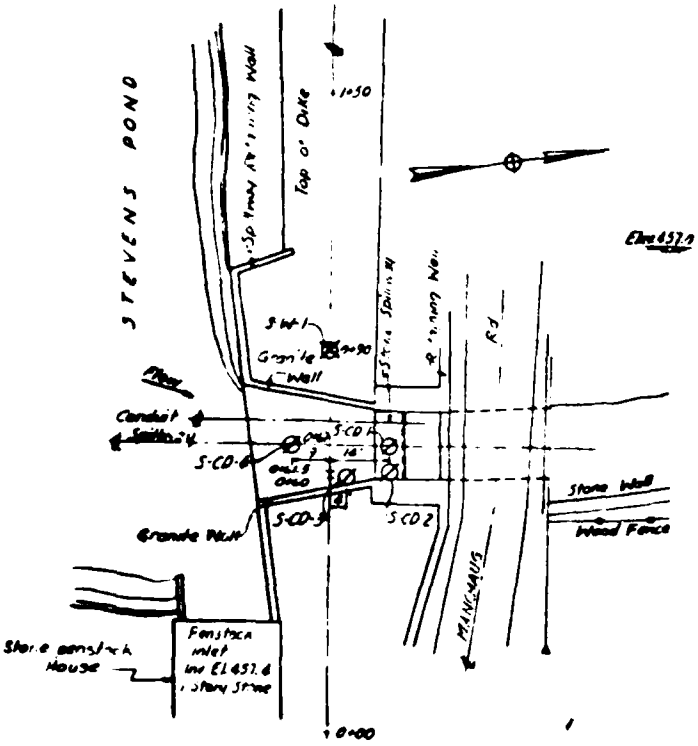
Engineering Data



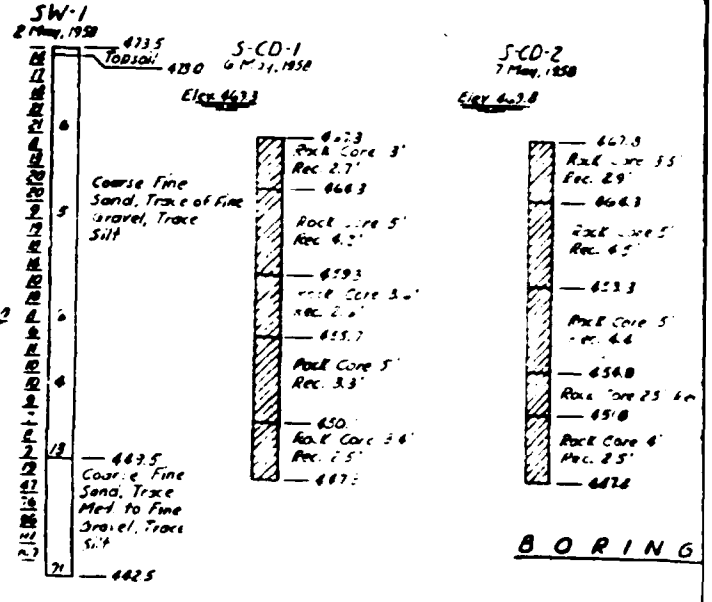
AREA PLAN
Scale 1"=40 Mi.



MANCHAUG POND DAM
Scale 1" = 20'



STEVENS POND DAM
Scale: 1" = 20'



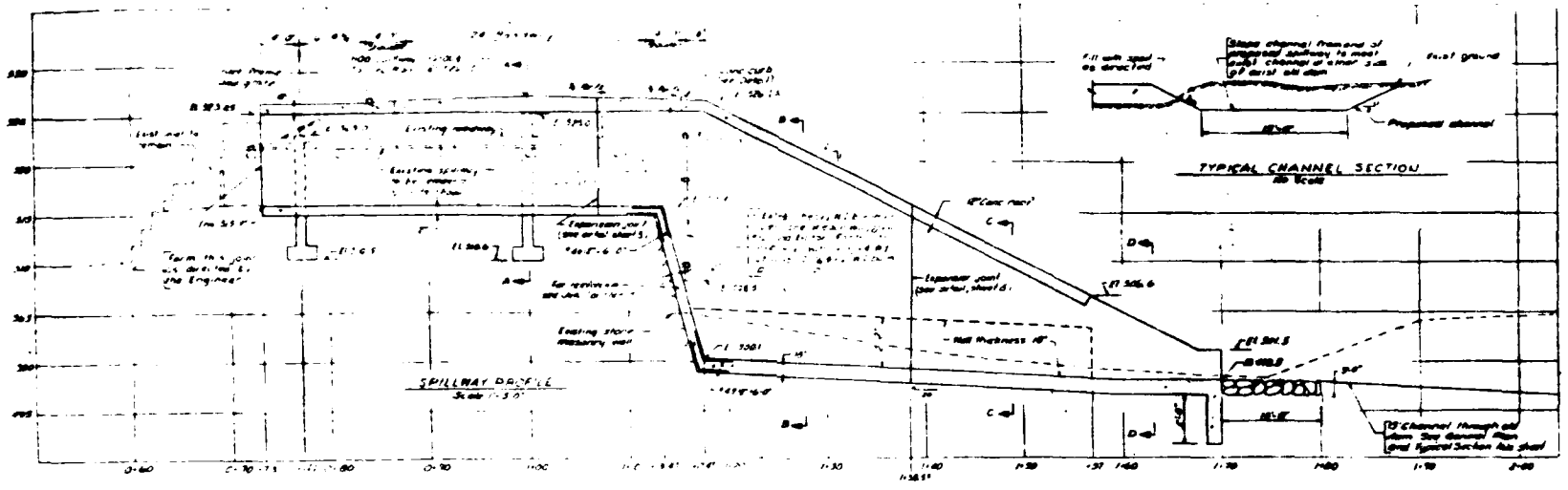
BORING

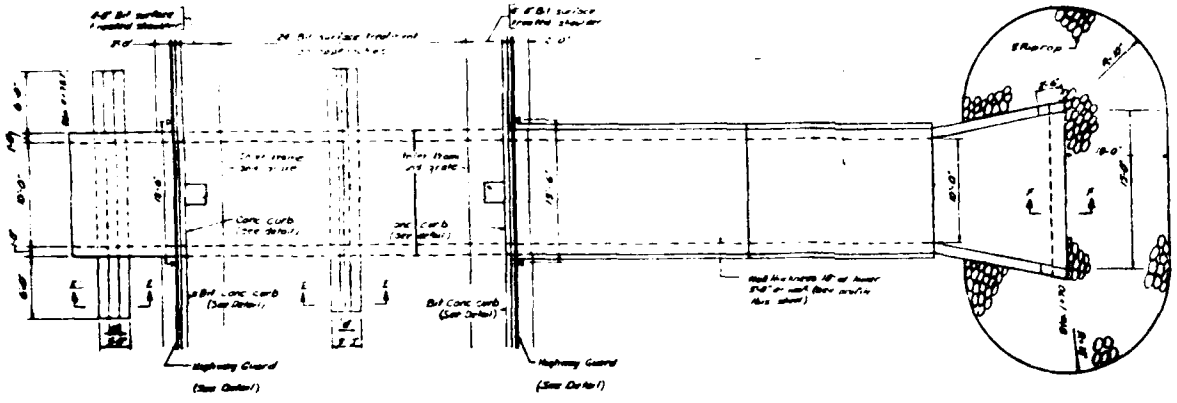
Notes:

1. Borings were taken for purposes of design and show conditions at boring points only, but do not necessarily show nature of materials to be encountered during construction.

2. Figures on columns indicate blows per foot on 2" Ø sampler produced by 30" fall of 140 lb. hammer.

3. Figures at left of columns indicate blows per foot on 6" Ø casing produced by 24" fall of 300 lb. hammer.





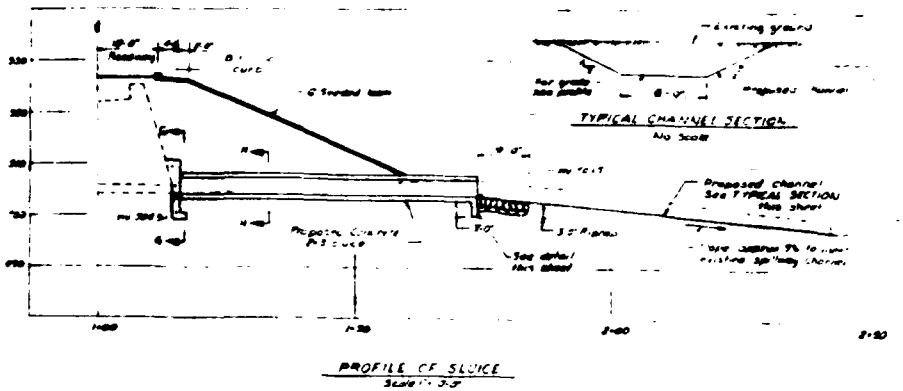
SPILLWAY PLAN
Scale 1"=5'-0"

NOTE: For detail of anchors see Sheet 8 of 9

PROPOSED DAM REPAIR
STEVENS AND MANCHAUG PONDS
SMIPPEE RIVER, SUTTON, MASS.
DEPARTMENT OF PUBLIC WORKS OF MASSACHUSETTS

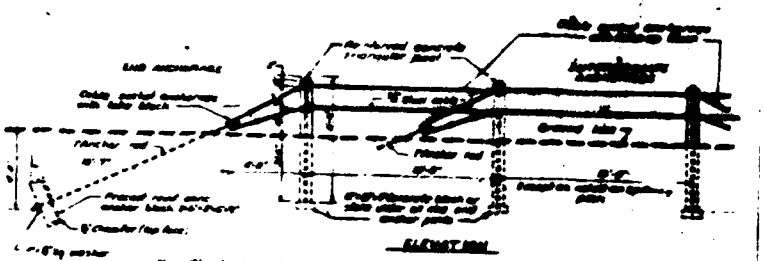
SPILLWAY PLAN & PROFILE
MANCHAUG POND

GREEN ENGINEERING ASSOCIATES, INC.
BOSTON

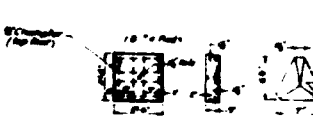


PROFILE OF SLUICE

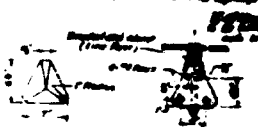
TYPICAL CHANNEL SECTION



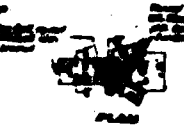
ELEVATION



PRECAST REINF CONC ANCHOR BLOCK



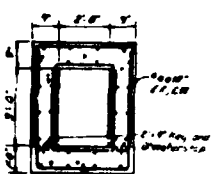
CONCRETE POST

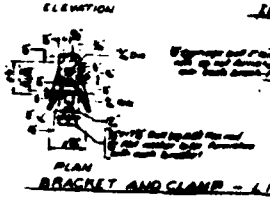


PLAN

ELEVATION

ELEVATION

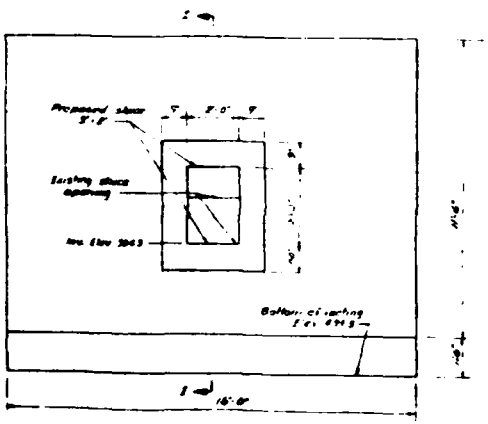




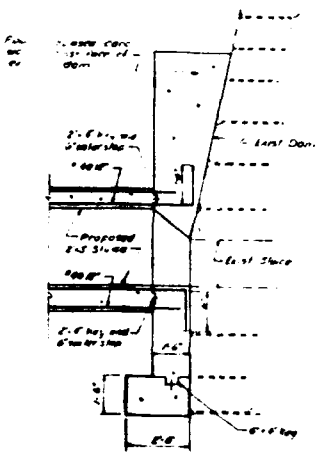
PLAN ELEVATION

BRACKET AND CLAMP - LINE POSTS

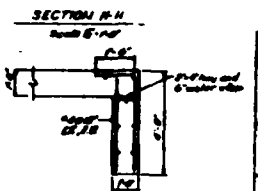
HIGHWAY GUARD TYPE C-P-C



SECTION G G



SECTION J J

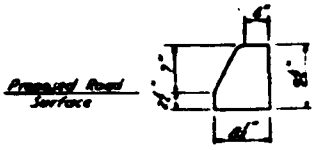


SECTION H-H

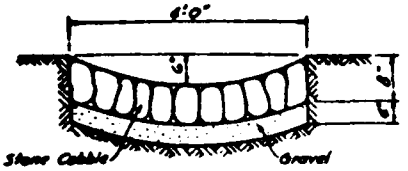
DETAIL OF CONCRETE SLUICE CHUTE

PROPOSED DAM REPAIR
STEVENS AND HAMBURG PONDS
NISSEQUOGUE RIVER, CUTLER, MASS.
DEPARTMENT OF PUBLIC WORKS OF MASSACHUSETTS
BUREAU OF WATERWAYS

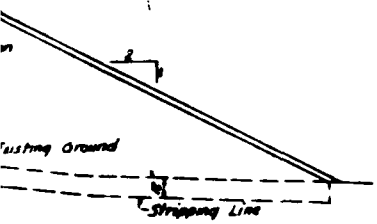
SLUICE AND MISCELLANEOUS DETAILS
HAMBURG POND

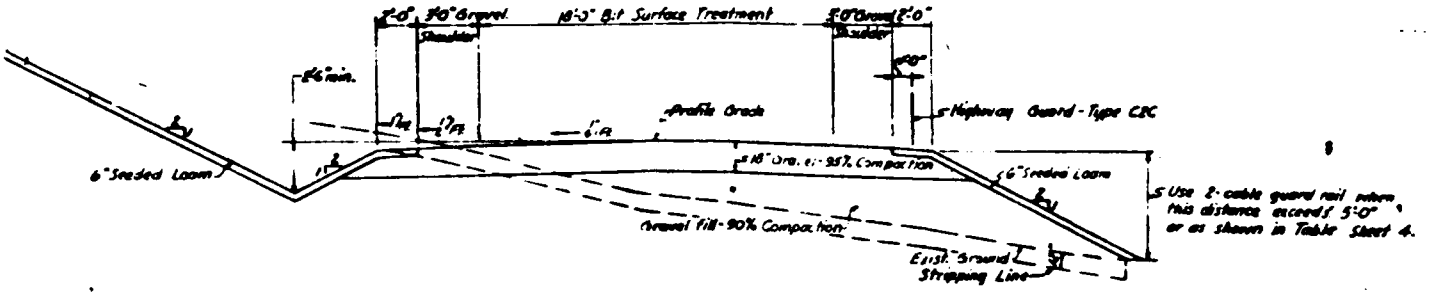


BITUMINOUS CONCRETE CURB DETAIL
Scale: 1"=1'-0"



COBBLE STONE GUTTER
Not to Scale





TYPICAL SECTION-HOLT RD. & PARKER RD.
Scale 1/4"=1'-0"

Use 8-cable guard rail when this distance exceeds 5'-0" or as shown in Table Sheet 4.

PROPOSED DAM REPAIR
STEVENS AND MANCHAUG PONDS
MUMFORD RIVER, SUTTON, MASS.
DEPARTMENT OF PUBLIC WORKS OF MASSACHUSETTS
DIVISION OF WATERWAYS

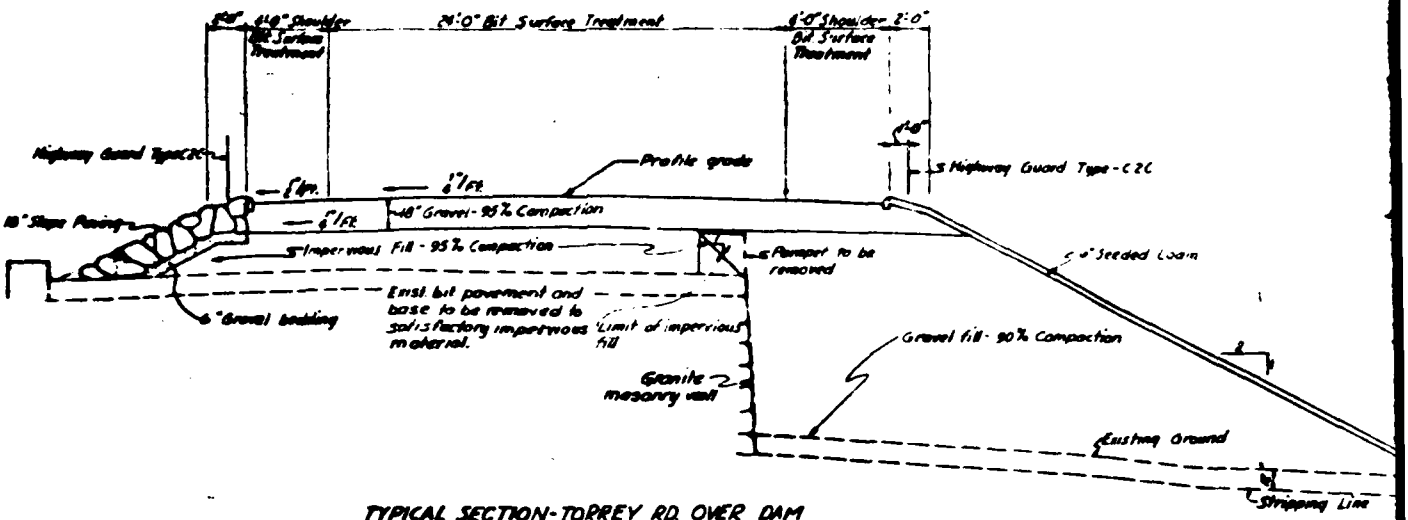
DETAILS AND TYPICAL SECTIONS
MANCHAUG POND

SHEET NO. 8 OF 9

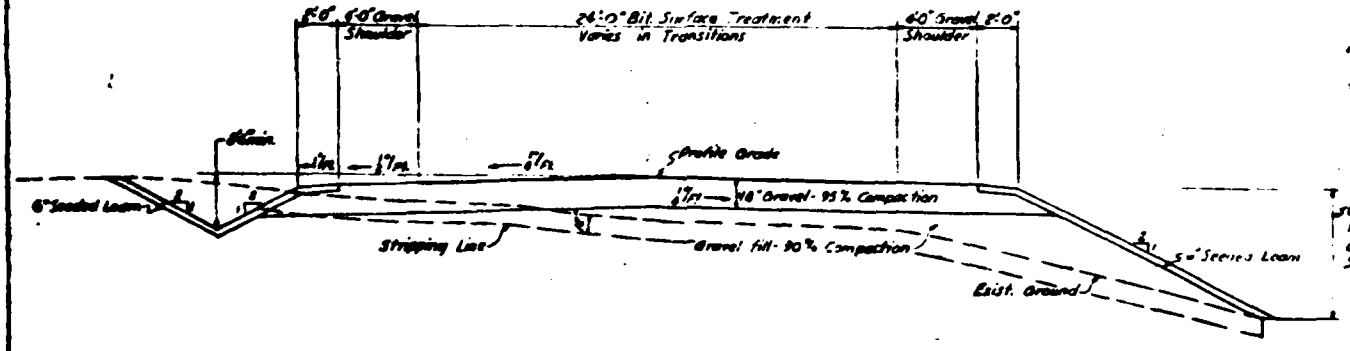
GREEN ENGINEERING ASSOCIATES, INC.
ENGINEERS BOSTON

DESIGNED CAG SCALE: AS SHOWN
DRAWN E.J.G. DATE: JANUARY, 1968
CHECKED HCH CONTRACT NO. 1968

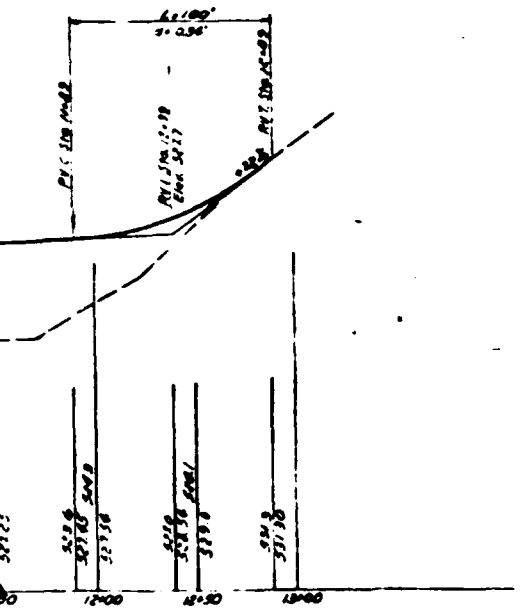
CHIEF DIVISION OF WATERWAYS ENGINEER
DEPT. PUBLIC WORKS

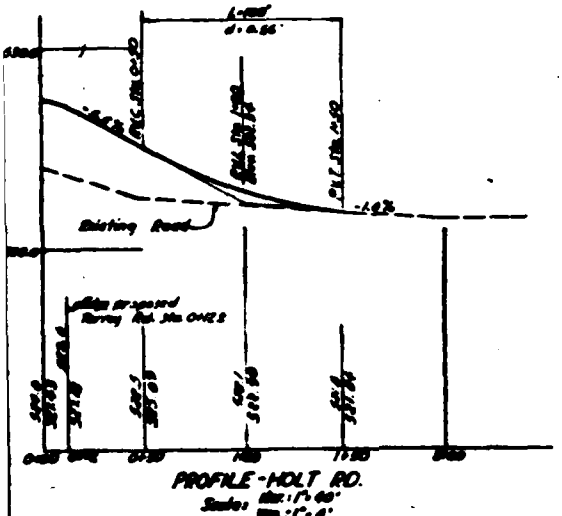


TYPICAL SECTION-TORREY RD. OVER DAM
Scale ¼"=1'-0"



TYPICAL SECTION - TORREY ROAD
Scale ¼"=1'-0"



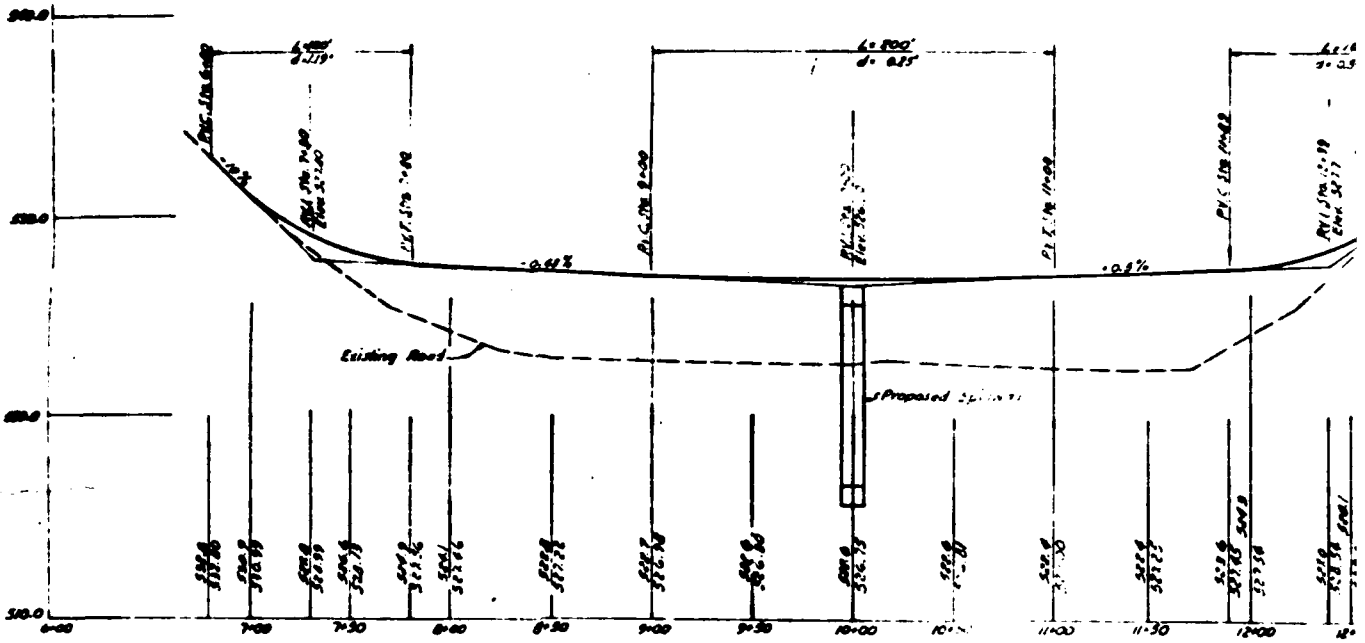


NOTES:
1. All existing pavement shall be scarified before placing fill
2. Profile grades and crown slopes shall be adjusted as directed to meet existing pavements.

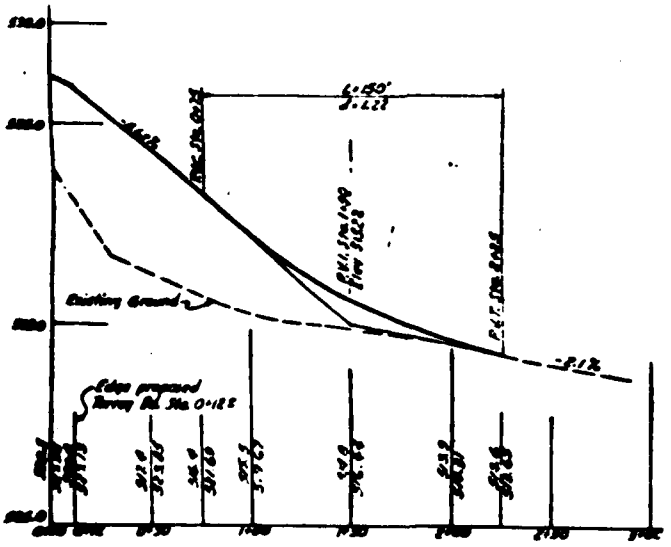
PROPOSED DAM REPAIR
STEVENS AND MANCHAUG PONDS
MUMFORD RIVER, SUTTON, MASS.
DEPARTMENT OF PUBLIC WORKS OF MASSACHUSETTS
DIVISION OF WATERWAYS

PROFILES — MANCHAUG POND

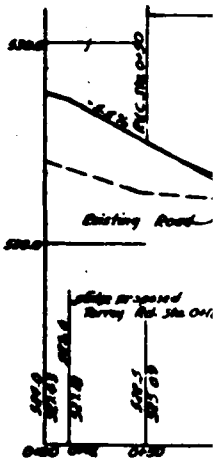
GREEN ENGINEERING AFFILIATES, INC.
ENGINEERS BOSTON

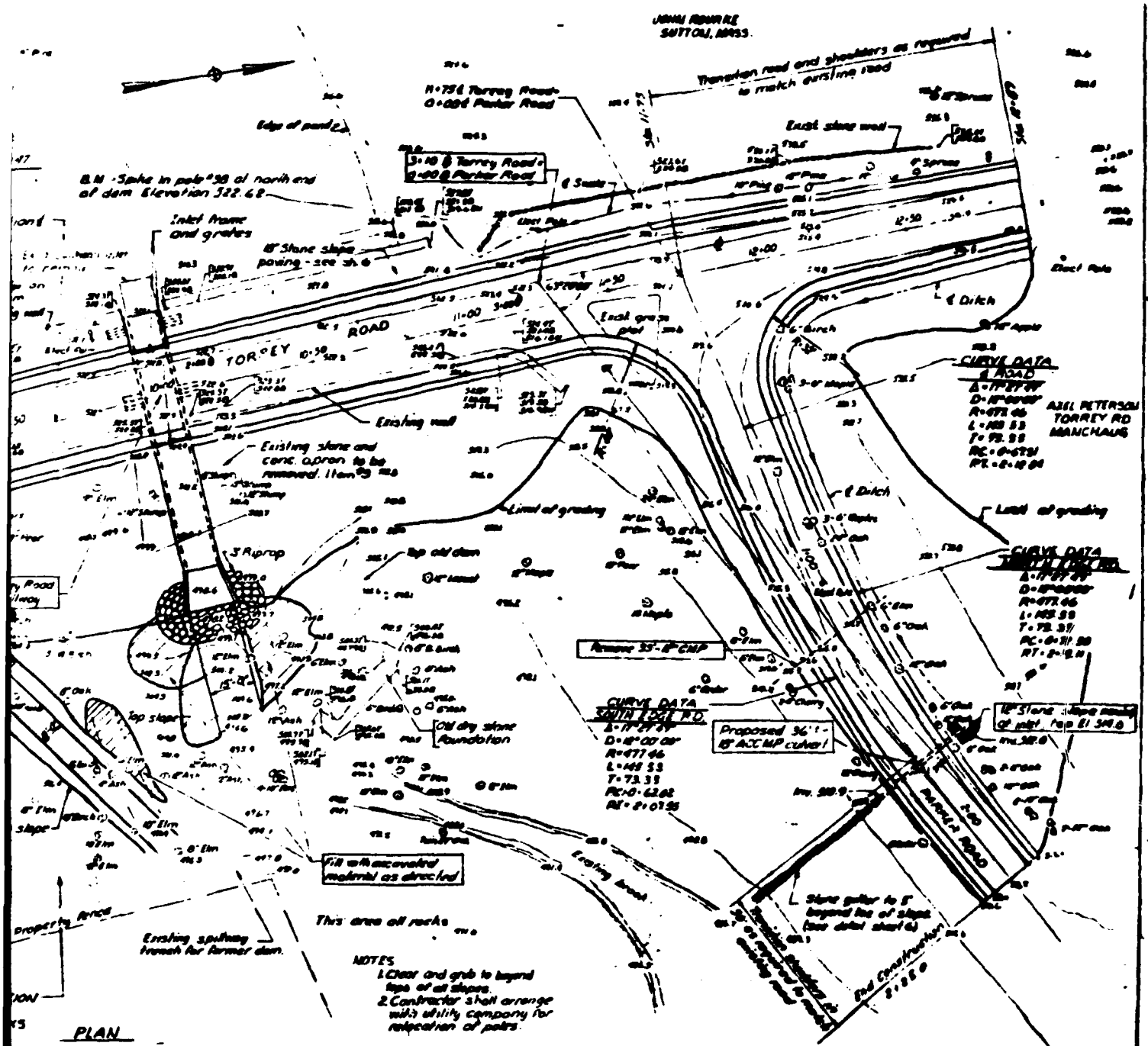


PROFILE - TORREY RD
Scale: Hor: 1" = 60'
Ver: 1" = 6'



PROFILE - PARKER RD.
Scale: Hor: 1" = 60'
Ver: 1" = 6'





PLAN

Scale 1" = 80'-0"

PROPOSED DAM REPAIR
STEVENS AND MANCHAUG PONDS
MUMFORD RIVER, SUTTON, MASS.
DEPARTMENT OF PUBLIC WORKS OF MASSACHUSETTS
DIVISION OF WATERWAYS

GENERAL PLAN - MANCHAUG POND

GREEN ENGINEERING AFFILIATES, INC.
ENGINEERS
BOSTON

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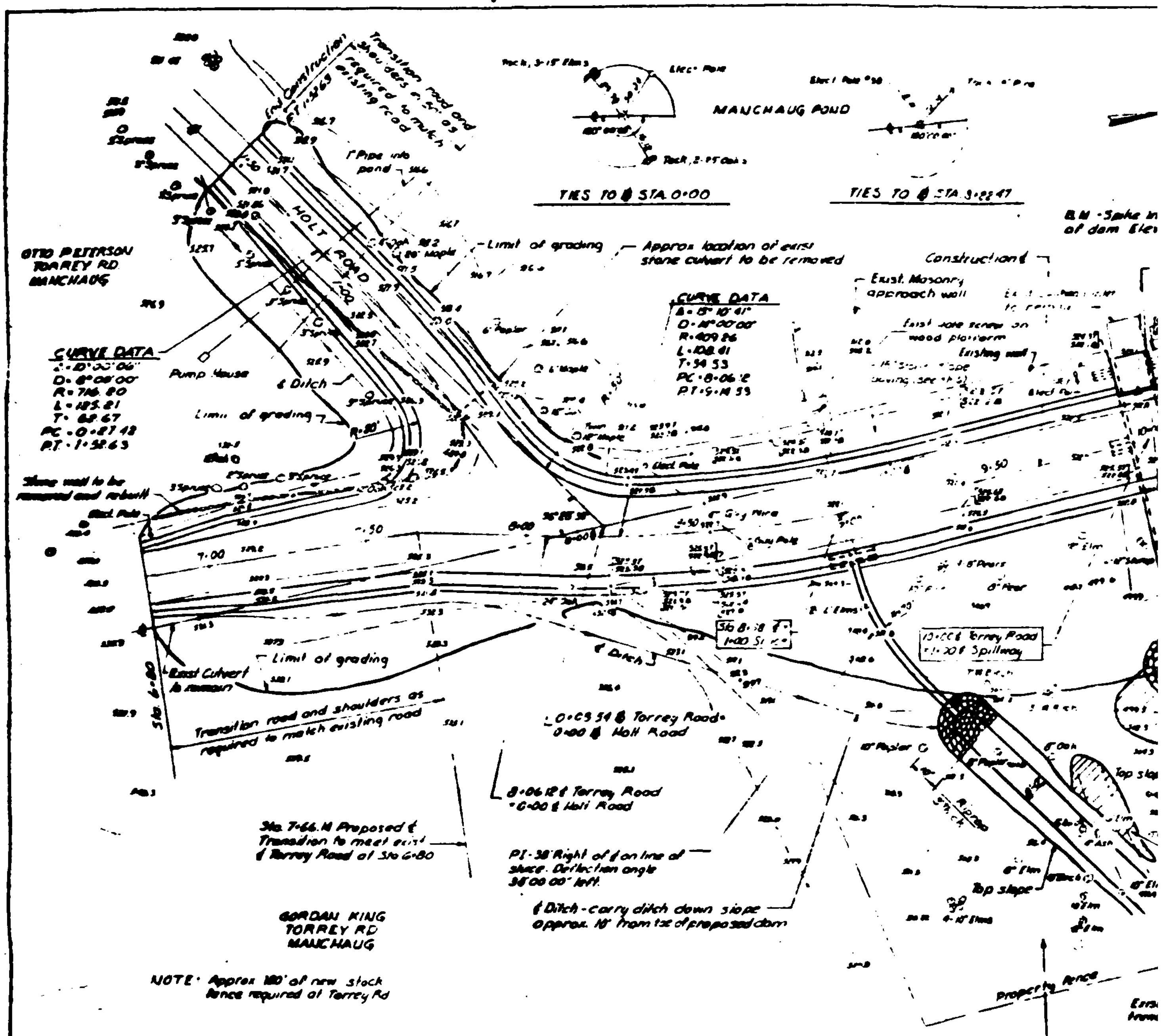
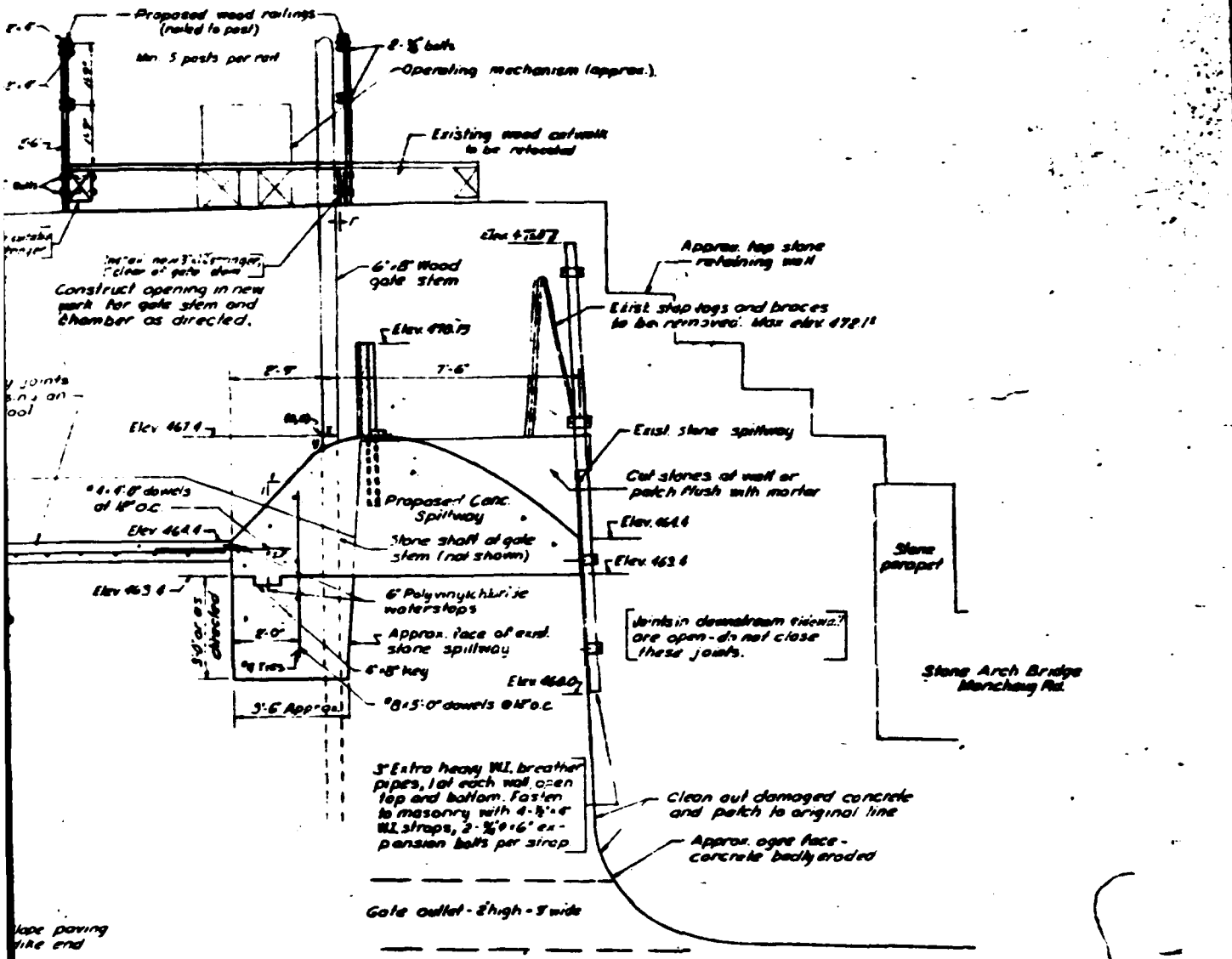


LIMIT OF CURBING, GUARD RAIL AND STONE PAVING	
CURBING AND PAVED SHOULDER	From Station 8+80 right to 11+35 right and from Station 8+83 left to 11+12 left of ¢ Torrey Road
GUARD RAIL	From Station 0+95 right of ¢ Holt Road to 11+00± left ¢ Torrey Road and from Station 8+30± right ¢ Torrey Road to 8+83± right ¢ Parker Road.
STONE PAVING	From Station 8+83± to Station 10+96± ¢ Torrey Road.

LOCATION OF ¢ ROAD		
¢ STATION	OFFSET	¢ STATION
TORREY ROAD		
1+00	11.5 Right	9+17.33
1+82.5	10.86 Right	10+00
HOLT ROAD		
1+00	1.0 Right	P.I. of Curve
PARKER ROAD		
1+62	1.5 Right	P.I. of Curve

PLAN
Scale 1"=80'-0"

Pond Area = 345.6 Acre
Watershed Area = 4134.4
Storage Capacity = 2330

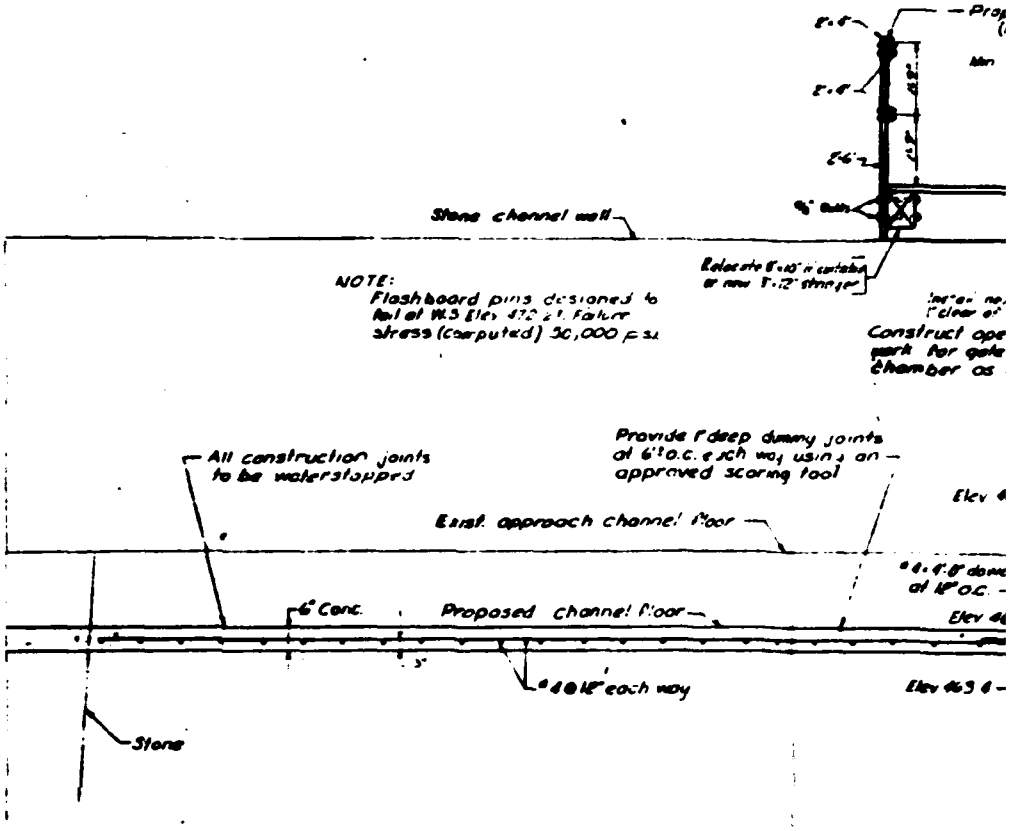


PROPOSED DAM REPAIR
STEVENS AND MANCHAUG PONDS
MUMFORD RIVER, SUTTON, MASS.
DEPARTMENT OF PUBLIC WORKS OF MASSACHUSETTS
DIVISION OF WATERWAYS

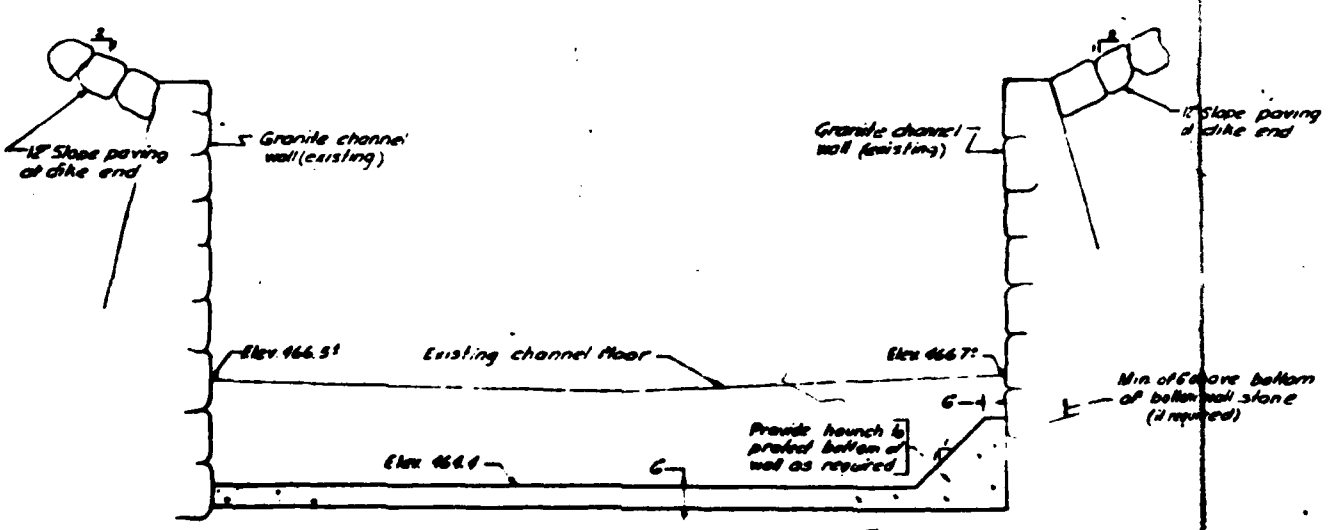
PROFILE AND DETAILS - STEVENS POND

B-3

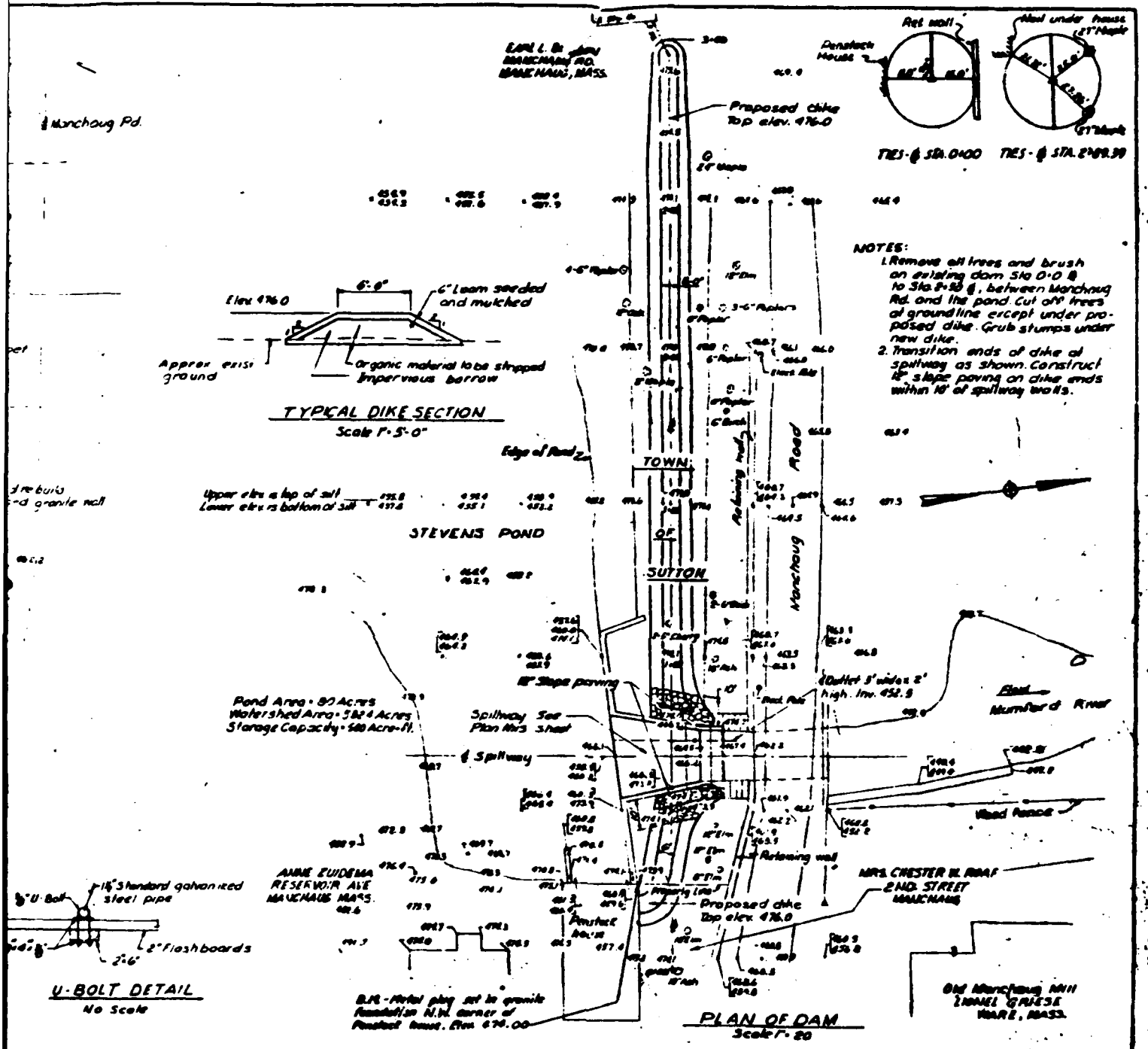
CO-ORDINATES OF PROPOSED SPILLWAY	
(0,0) FS AT ELEV. 462.4, 7'-6" FROM DOWNSTREAM FACE	
X	Y
0.00	0.28
0.65	0.07
1.30	0.00
1.95	0.03
2.80	0.13
3.90	0.58
5.20	1.26
6.50	2.16
7.30	3.00



PROFILE OF SPILLWAY
Scale ½" = 1'-0"



TYPICAL APPROACH CHANNEL SECTION
Scale ½" = 1'-0"



PROPOSED DAM REPAIR
STEVENS AND MANCHAUG PONDS
MUMFORD RIVER, SUTTON, MASS.

DEPARTMENT OF PUBLIC WORKS OF MASSACHUSETTS
DIVISION OF WATERWAYS

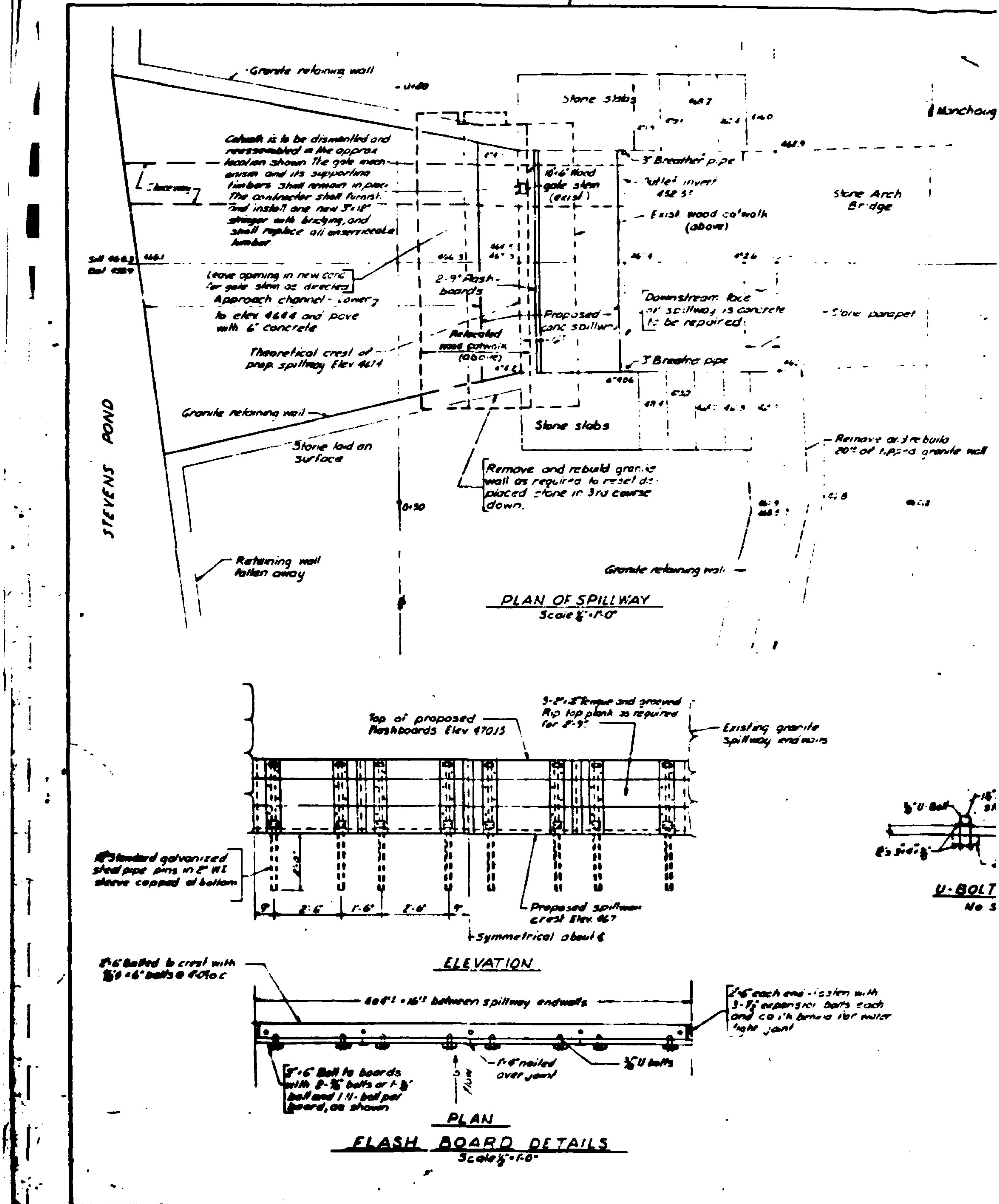
PLANS AND DETAILS — STEVENS POND

SHEET NO. 2 OF 9

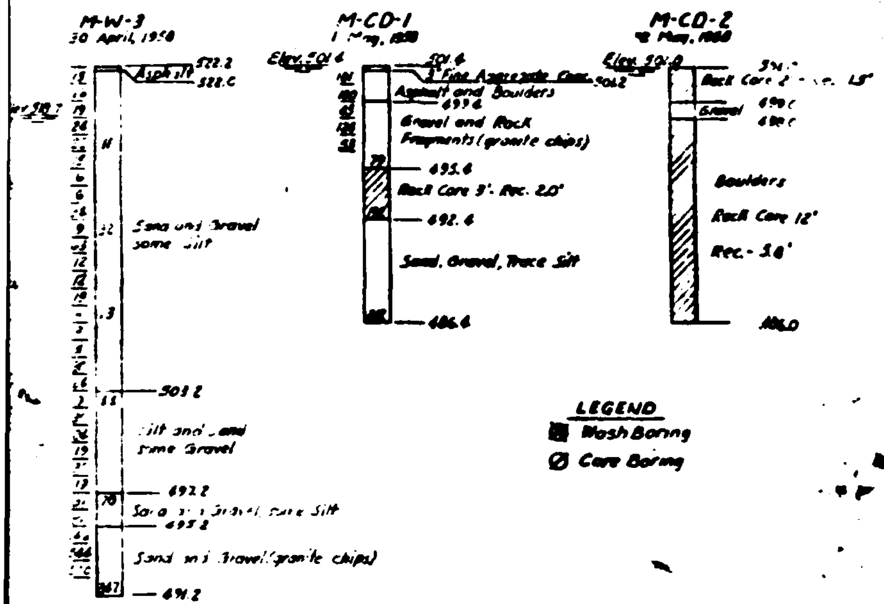
GREEN ENGINEERING AFFILIATES, INC.
ENGINEERS BOSTON

DESIGNED-CAG
DRAWN-ALP
CHECKED-HAM
SCALE-AS SHOWN
DATE: JANUARY, 1969
CONTRACT NO. 1969

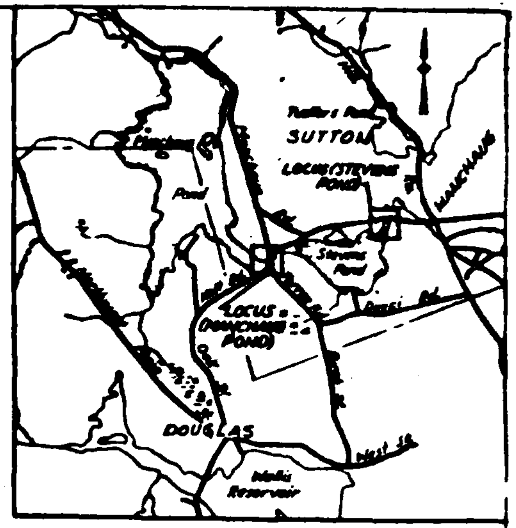
B-2


Granite retaining wall
Stone slabs
Manchaug
Catwalk is to be dismantled and reassembled in the approx location shown. The gate mechanism and its supporting timbers shall remain in place. The contractor shall furnish and install one new 3"x18" stringer with bridging, and shall replace all unserviceable lumber
3" Breather pipe
10"x6" Wood gate stem (exist)
Stone Arch Bridge
Exist. wood catwalk (above)
Leave opening in new conc for gate stem as directed
2'-9" Flash-boards
Approach channel - lower to elev 464.4 and pave with 6" concrete
Proposed conc spillway
Downstream face of spillway is concrete to be repaired
Stone parapet
Relocated wood catwalk (above)
Theoretical crest of prop. spillway Elev 461.4
3" Breather pipe
Granite retaining wall
Stone laid on surface
STEVENS POND
Remove and rebuild granite wall as required to reset displaced stone in 3rd course down.
Remove and rebuild 20'± of tipped granite wall
Retaining wall fallen away
Granite retaining wall
PLAN OF SPILLWAY
Top of proposed flashboards Elev 470.15
Existing granite spillway endwalls
Standard galvanized steel pipe pins in 2" W.I. sleeve capped at bottom
Proposed spillway crest Elev. 467
Symmetrical about ℄
ELEVATION
U-Bolt
U-BOLT
Bolted to crest with bolts @ 4'-0" o.c.
between spillway endwalls
each end with expansion bolts each and caulk for water tight joint
Bolt to boards with 2-⅝" bolts or 1-⅝" bolt and 1-U-bolt per board, as shown
1"x4" nailed over joint
⅝" U bolts
Flow
PLAN
FLASH BOARD DETAILS

3

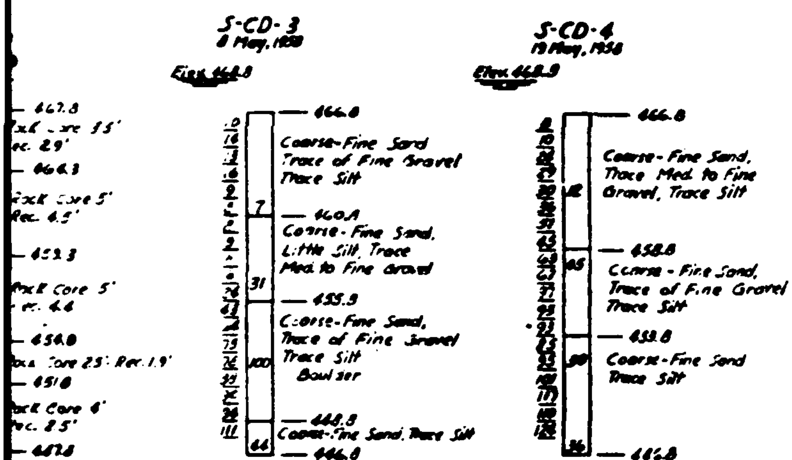


BORING LOGS



LOCATION PLAN
Scale: 1" = ½ Mile

INDEX OF DRAWINGS	
Dwg. No.	Description
1	Location Plans and Boring Data
2	Plans and Details - Stevens Pond
3	Profile and Details - Stevens Pond
4	General Plan - Manchaug Pond
5	Profiles - Manchaug Pond
6	Details and Typical Sections - Manchaug Pond
7	Spillway Plan, and Profile - Manchaug Pond
8	Spillway Details - Manchaug Pond
9	Sluice and Miscellaneous Details - Manchaug Pond



General Notes:
1. B.M.'s and Baseline Ties Shown on General Plans
2. Transit book reference: #768, #789 and #826

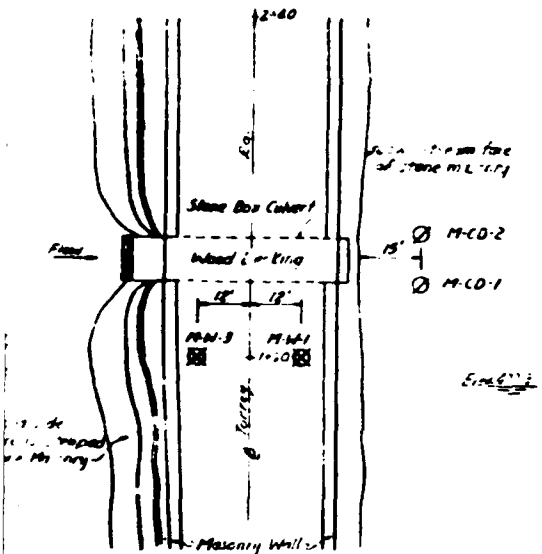
BORING LOGS

PROPOSED DAM REPAIR
STEVENS AND MANCHAUG PONDS
MUMFORD RIVER, SUTTON, MASS.
DEPARTMENT OF PUBLIC WORKS OF MASSACHUSETTS
DIVISION OF WATERWAYS

LOCATION PLANS AND BORING DATA — SHEET NO. 1 of 9

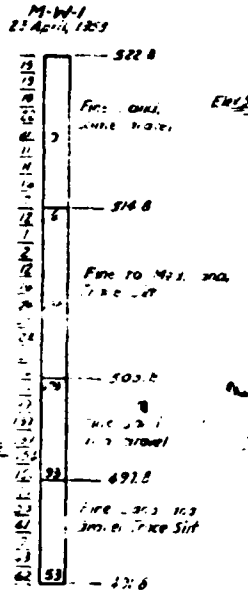
GREEN ENGINEERING AFFILIATES, INC.
ENGINEERS BOSTON

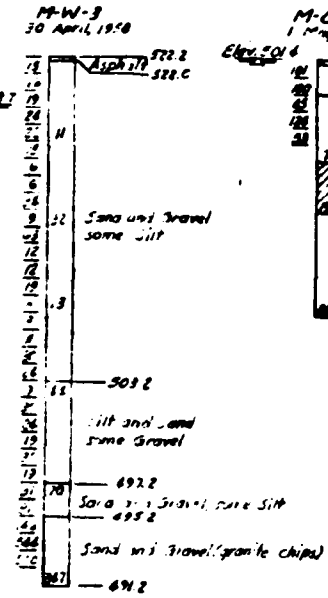
DESIGNED: C.A.G. | SCALE: AS SHOWN
DRAWN: B.J.G. | DATE: JANUARY, 1959
CHECKED: H.B. | CONTRACT NO.

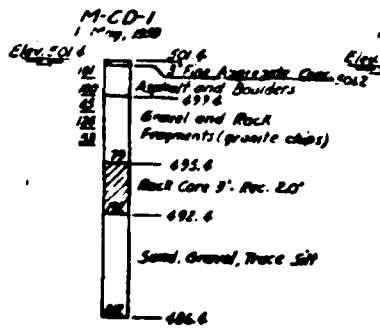


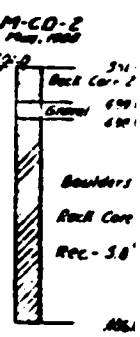
MANCHAUG POND DAM

Scale: 1" = 20'







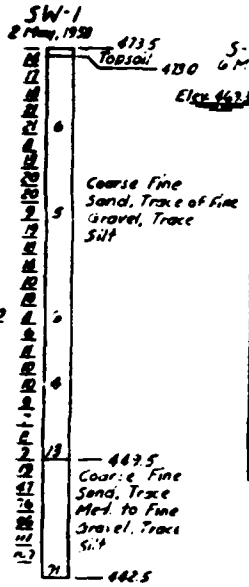


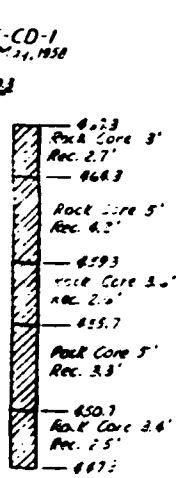
LEGEND

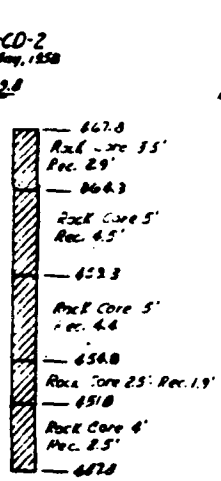
Wash Boring

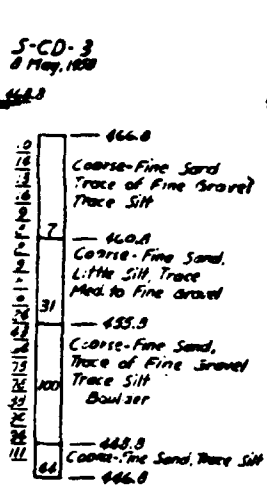
Core Boring

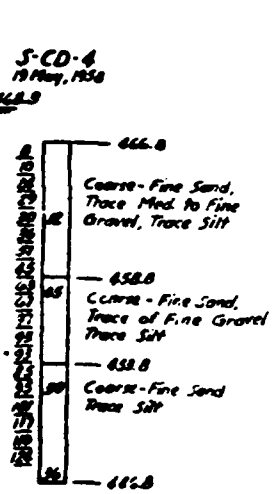
BORING LOGS











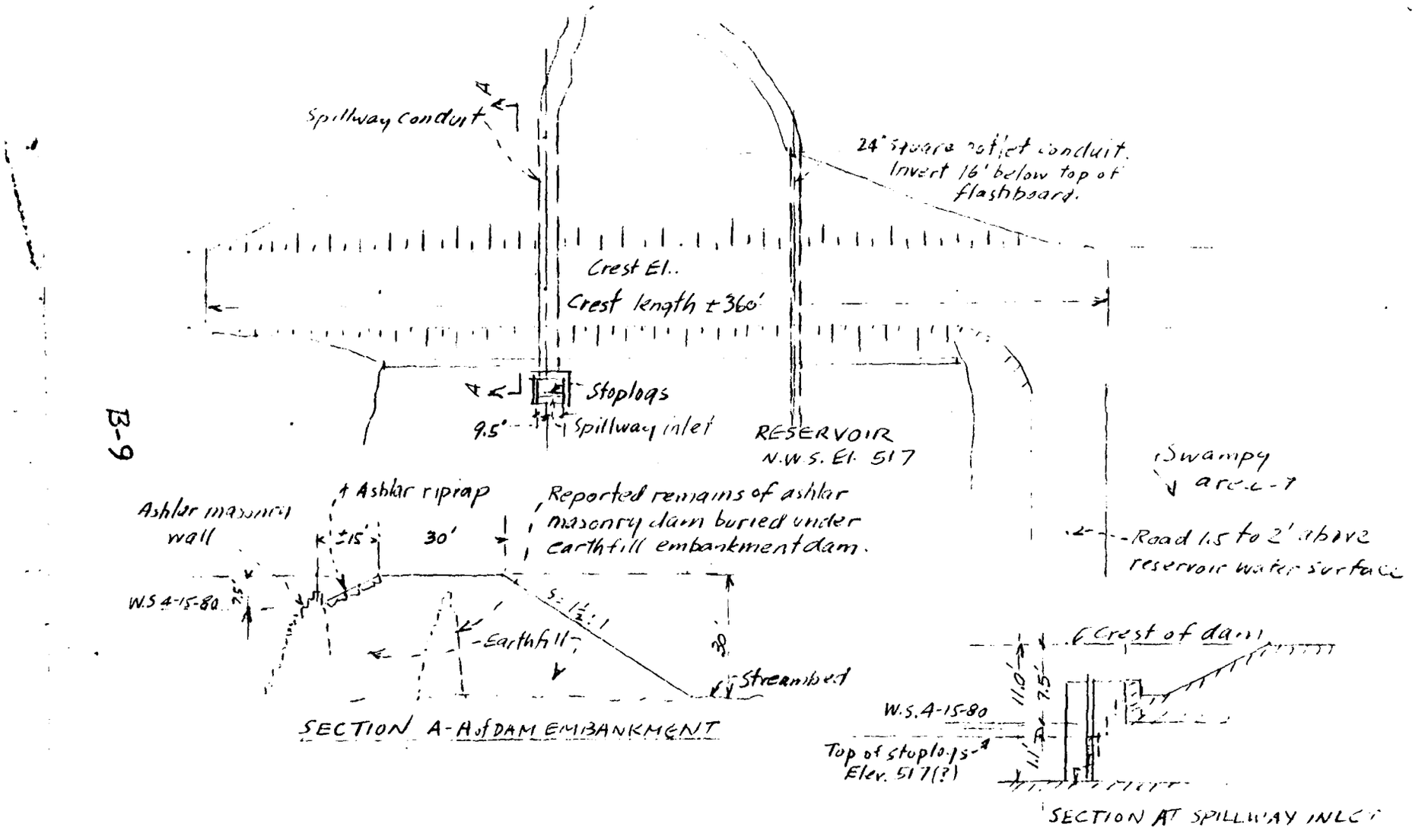
BORING LOGS

Notes:

1. Borings were taken for purposes of design and show conditions at boring points only, but do not necessarily show nature of materials to be encountered during construction.

2. Figures on columns indicate blows per foot on 1⅜" ID sampler produced by 30" fall of 140 lb. hammer.

3. Figures at left of columns indicate blows per foot on 5" OD casing produced by 24" fall of 300 lb. hammer.



B-9

MANCHAUG RESERVOIR DAM

height of the flash boards has been lower 1, making it safer. There is one portion of this dam southerly of the spillway between the spillway and Douglas Road which appears to have bulged and at present there seems to be no apparent leakage, but someday it might be advantageous to have this investigated and either install buttresses or put fill behind this area to give the dam more body.

The third dam is located to the easterly side of Castle Hill Road and is a block granite dam. Both this and the Lower Mouse Dam probably have some type of a core, at least puddled clay, but there are no plans to my knowledge to show the original construction. This latter dam we call the Whitin Estate Pond Dam. It is a small dam which was on a former Whitin estate and backs up a small body of water approximately 3' in depth. This dam has a gate structure which, to my knowledge, has never been used. It has an overflow and after the '55 flood had a second overflow installed wider than the original and 3" higher than the normal overflow to function only in case of flood. This dam has no value to the plant other than an aesthetic value. Since the company turned over the larger body of water upstream known as Riley's Pond, it is of no value to the plant operation.

✓ The fourth dam known as Lackey Dam is owned by the company. It is an old timber and wood log dam with granite block side walls at each end and a dual gate structure operated with rack and pinion. The length of the spillway is 66' and the dam carries two permanent flash boards on the top of the spillway. The gate structure was rebuilt in November of 1955 shortly after the flood. The log timber cribs were in such a state that it was decided if we tried to make a major repair we would end up replacing the dam. Therefore, the back slope of the dam was replanked over the old planking and the planking is covered with a blanket of clay. This is to cut down seepage of water through the st[illegible] New irons and flashboard supports and flashboards were installed. [illegible]een settling - that is the log crib part on the end oppos[illegible]ructure end and is about 3" out of level at present. This is [illegible]s planning to replace the triple stone arch bridge[illegible]n't know if their plans include any changes or [illegible]s dam backs up a body of water approxim[illegible]nd has no particular value for the [illegible]gate can be opened if you ne[illegible]ince the Whitinsville Wat[illegible]ow Pond and Mumford River joi[illegible]e Dam is cut down in size considerab[illegible] gate is approximately 3' by 4'in the west

EXCERPT OF LETTER
From: DELWYN BARNES
TO: JOSEPH ROSOL

✓ The next dam th[illegible] in is on the head waters of the Mumford River known as [illegible]eservoir. This dam is a granite block dam with granite block [illegible] rails on top, as the dam is crossed by the town highway. This dam [illegible] a bridge under the highway between the lake side of the dam and the spill[illegible] The spillway is approximately 36' in width, carrying 2' of removable flash boards. This flash board structure was just rebuilt in 1977. It also has an unrestricted spillway without flash boards which is approximately the same width and height. Both spillways overflow the water onto a granite ledge which runs all the way to the discharge stream below the dam. The dam also has a gate structure in the center with a 2' square gate operated on a vertical screw with a large nut. This structure, formerly of wood, was all replaced with steel after the '55 flood. The bridge seemed to be a bottleneck during the '55 flood so three large concrete culverts were installed through the roadway southerly of the bridge. This dam is owned by the Mumford River Reservoir Company of which the company's share is 10/16. The dam and some land below the dam and along the discharge brook and some land adjacent to the Reservoir

at the far end of the Reservoir are owned, I believe, by ATF/Davidson. Any dimensions other than what I have given you, with the exception of the depth of water which is 27' at full pond, I would have to obtain for you. The Mumford River Reservoir has a causeway which cuts the Reservoir roughly in half. This causeway, after some study, was proven to belong to the town and at that time the company repaired the culvert which joins the two bodies together and installed concrete guard rails on the culvert. The town maintains the roadways on the dam and on the causeway. The dam has been fenced on the down stream face with a chain link fence and the gate structure and overflow structure have also been fenced.

MANCHAUG RESERVOIR

The last and final dam is the Manchaug Reservoir Corporation Dam which is at present made up of two mills - ATF/Davidson owning 5/6. The Manchaug Reservoir Dam is a stone block dam as Mumford, and has a gate structure with a 2' square gate - the same type of operation with a vertical screw and nut. The spillway goes through the top of the dam and has removable flash boards. The spillway is 10' in width and is practically 10' high and carries flash boards 40" high. This dam originally had granite block guard rails, but after the '55 flood the Massachusetts Department of Public Works, Division of Waterways, made a study of the Stevens Pond Dam which is just down stream from the Manchaug Dam and was damaged during the flood. They decided to spend considerable money on the Manchaug Reservoir Dam so that it would act as a flood control dam and would thus protect the Stevens Pond Dam instead of spending a large amount of money on the Stevens Pond Dam without near as beneficial results. To do this they raised the dam's height and greatly reinforced the dam by adding a long slop embankment to the back side of the dam. The town highway also crosses this dam. At the same time, the State rebuilt the spillway and the bridge over the spillway and carried the spillway down to the back toe of the dam and covered this spillway to this point where it discharges into the stream. This is the same stream which the gate structure discharges into. The gate structure and the spillway structure have also been changed over to steel and fenced in by the Reservoir Company. The front face of the dam above the original granite block wall is rip rap. The highway crossing the dam is maintained by the town and has concrete and cable guard rails - also placed by the town.

The New Ring Shop Dam, the Power House Dam and the Whitin Estate Pond Dam are all located in the Town of Northbridge. Lackey Dam and Manchaug Dam are located in the Town of Sutton and the Mumford River Reservoir Dam is located in the Town of Douglas. Portions of Lackey Pond are in Sutton and Uxbridge and portions of Manchaug Pond are in Sutton and Douglas. Portions of the Mumford River backed up by the Power House Dam are in Northbridge and Sutton. The other two are in Northbridge.

The dams have been well maintained yearly, keeping all brush and grass mowed and doing all necessary pointing and masonry, repairing structures, etc. as necessary. The annual inspection used to be done by the Worcestery County Engineers. It is now handled by the State of Massachusetts. We have always been complimented on the maintenance of all these dams. They were viewed in detail in 1974 by Mr. Les McLean of the Travellers' Insurance Company. He viewed them again in 1977. The dams are now supervised and regulated by the Whitinsville Water Company who inspects and maintains the structures on an annual basis with visits to the dams as necessary, depending on weather conditions. Sometimes during critical periods these inspections are oftener than once a day.

The Manchaug Dam was built in 1836 and revamped in 1960 and the Mumford River dam was built in 1854. The Lackey Dam, I imagine, was built around the time of

the Power House Dam. These dams have gone through several critical floods, particularly the flood of 1955 when we had 13.69 inches of rain basically over a three-day period with 10 inches coming in one day.

These structures that are not enclosed in the plant area, are all posted for trespassing, and we have very good cooperation with the police forces in the three towns and have very few problems with vandalism.

The Mumford and Manchaug Dams (as well as the Carpenter Reservoir Dam which was a power dam and sold to the Whitinsville Water Company) were built to store water to make sure that the different companies owning shares would have a constant supply of water to operate throughout the year. The amount of water to be drawn was all restricted. This practice is still followed, except that now that the mills are not as many and are not wholly dependent on water power and since there are more campers around the reservoirs, we try to favor the campers during camping season.

The land under the reservoirs was acquired for flowage rights and are not directly owned, but the dams and other areas mentioned are owned direct.

If there is any further information you might wish to have, I'll be glad to try to obtain it for you.

Very truly yours,

Delwyn D. Barnes
Vice President

DDB:cpp

B-12

(27) TOWN OR CITY Sutton DECREE NO. PLAN NO. F... DAM NO. 50-04

LOCATION 1 mile West of Manchaug C. C. DOCKET NO.

DESCRIPTION OF DAM El 569.44

Type Cut gran. Face 1/4:1 Slope - Highway

Length 255'

Height Spillway = 14.67 Main Dam = 20.44

Thickness top 39

" bottom 60' - 70'

Downstream Slope Face 1/4:1 slope

Upstream " Rear Stepped granite blocks.

Length of Spillway 10.3 El. top 563.67

Size of Gates 3x3 El. 553.76

Location of Gates 70' - No. - So. End Dam

Flashboards used

Width Flashboards or Gates El. 566.34

Dam designed by

" constructed by

Year constructed 1870.

DESCRIPTION OF RESERVOIR & WATERSHED

Name of Main Stream Manchaug Pond

" " any other Streams

Length of Watershed

Width " "

Is Watershed Cultivated

Percent in Forests

Steepness of Slope

Kind of Soil Rocky - ✓

No. of Acres in Watershed 6.7 Sq. miles

" " " Reservoir Cu. ft. Cap. 191 Million 360.

Length of Reservoir Inflow 2.7 Rare Flood

Width " "

Max Flow Cu. Ft. per Sec.

Head or Flashboards-Low Water

" " " -High "

GENERAL REMARKS

Owner: Manchaug Reservoir Co. ~~...~~

Recent repairs: None - ~~Whitin Machine Works~~ Whitinsville

Leakage: None

Condition: Good

Topog.: Wooded

Arthur Whitin - Frank Putnam controls gates

Inspected: Sept. 19, 1924 L.O. Marden.

" " : June 11, 1931 " "

Frank Putnam controls gates

GENERAL REMARKS

~~Inspected Aug. 1. 1928 L.O. Marden~~

" Dec. 30, 1931 " "

" : 3-30-37 - K.M.F., Willard Burnap

" : 10-17-38 - L. H. Spofford

Meas : 3.25.27.39 - K.M.F.

Inspected : Dec. 13, 40 - L. H. Spofford

" : 12-9-42 - K.M.F.

" : 4-15-44 - L.O. Marden

~~1938 Flood~~ ~~TUA564~~ 2

Inspected: Dec. 10, 1945 - L.H. Spofford

" Nov. 18, 1946 - L.O.M. - D.K. Barnes (Nov. 1, 1960 LOM)

" Jan 8 1953 L.H. Spofford & Delbert Barnes

" Nov. 1, 1950 - W.O.L.

" Nov. 22, 1960 - W.O.L - G.J.C - R. Dockum - Res. Eng.

" June. 15, 1961 - " nearly complete

Vol. 8 pg 470 - Dec 1825 - Accepted proposed dam for Blackstone Canal Corp. - Manchaug Pond - on land of Mrs Silvanny Joslyn, Cyrus Putnam.

B-13

50-04

The following dam inspection reports are available from the Worcester County Engineer:

Sept.	19,	1924
Aug.	1,	1928
June	11,	1931
March	30,	1937
Oct.	17,	1938
Sept.	23,	1938
March	16,	1939
March	25,	1939
Dec.	13,	1940
Dec.	9,	1942
Dec.	10,	1945
Nov.	15,	1946
Jan.	8,	1953
Aug.	23,	1955

In 1960-61 the dam was reconstructed. Pertinent inspection reports are included on the following pages.

TOWN Sutton DAM NO. 50-04

LOCATION At intersection Holt & Torrey Rds. STREAM Mumford River - Branch "Manchang Pond"

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Town of Sutton Place Selectmen Use Storage Pond

Inspected by WOC Date 1960-1961

Type of Dam Highway Embankment Condition Under Construction

SPILLWAY

Flashboards in Place _____ Recent Repairs _____

Condition _____

Repairs Needed _____

EMBANKMENT

Recent Repairs _____

Condition _____

Repairs Needed _____

GATES

Recent Repairs _____

Condition old gate remains - no work required on gate

Repairs Needed "Gate is controlled by Whitin Machine Works.

LEAKS

How Serious _____

DATE: _____ County Engineer

(OVER) B-15

Nov. 1, 1960 WOL - GJC. New concrete spillway has been completed by T & T. Construction Co. of Winchester, Mass. Mr. Taskjian is foreman Richard Dockum is Resident Engr. for Green Associates of Boston, Consulting Engrs.
Embankment is under construction. Old roadway has been realigned and raised according to plans. Riprap on upstream slope has been completed. Construction is good.
No reconstruction required at gate

Nov. 10, 1960 WOL. Contractor is working on embankment

Nov. 16, 1960 WOL. Work as completed has been approved by McKinnon and Hoyle from MDPW - Waterways Division. Dockum and Contractor also on job.
Small leak is visible below spillway outlet - not serious - to check leak when boards are replaced to see if leak increases with higher pond level.
Embankment is under construction. Contractor will try to complete all work required on highway embankment including gravel, guard rail etc. Surfacing to be done in 1961.
Stone paving in outlet channel below gate.

Nov. 22, 1960 WOL GJC - Dockum - Whitin Machine 6 men are installing new pins for flash boards - to reuse old flash boards @ 3' in Ht. Hooks on boards are in poor condition - boards are fair.
Contractor is not on job this week - he will return next week to finish this project for this year. Gravel roadway fill is nearly completed. - very course material - should use finer course for topping Guard rail is not in place on this date.
Leak is still visible below spillway.

June 15, 1961 WOL - Leaks in old stone abutment in rock of flash boards to be repaired by Whitin Machine Works (Del Barnes, Engr.) this Fall when boards are removed. Leaks are not serious at this time - quite small Surface of roadway is ready for Asphalt - Guard rail is not completed to-date.
Project is nearly completed.

TOWN Sutton DAM NO. 50-04

LOCATION Manchaug Res 6 STREAM

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Manchaug Res Co Place Use

Inspected by P. B. Walker - Delwyn Barnes Date Oct. 6, 1961
Treas Mgr W. W. Sta

Type of Dam Condition Good
except see below

SPILLWAY

Flashboards in Place Recent Repairs

Condition

Repairs Needed

EMBANKMENT

Recent Repairs

Condition

Repairs Needed

West side thy both sides of Intake - water impounded in North & South Gutts

GATES

Recent Repairs

Condition

Repairs Needed Flashbds in open 18".

LEAKS

How Serious

DATE: County Engineer

TOWN Sutton DAM NO. 50-04

LOCATION Manchaug Res STREAM

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

D A M I N S P E C T I O N R E P O R T

Owned by Whitin Mach Co part owner Manchaug Res Co. Inc Place Whitinsville Use

Inspected by L.O.M. Don Barney Date April 5, 1962.

Type of Dam Condition

SPILLWAY

Flashboards in Place 30" Recent Repairs

Condition New Conc. Bridge blt Watermans MDPW

Repairs Needed Cyclone Fence - 2 sides + 1 side along Rt

EMBANKMENT

Recent Repairs

Condition New Riprap blt by W. Wks Div MDPW

Repairs Needed

GATES

Recent Repairs Removed 1961 - Cyclone Fence erected

Condition Good

Repairs Needed None

LEAKS

How Serious

DATE: County Engineer

TOWN Sutton DAM NO. 50-04

LOCATION Torrey Rd STREAM Mumford River
"Manchaug Pond"

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Manchaug Reservoir Co and Town of Sutton Place Whitinsville Selectmen Use Storage & recreation

Inspected by W.O.C. - G.V.C. Date Sept. 26, 1963

Type of Dam Highway Embankment Condition Good

SPILLWAY

Flashboards in Place No boards on this date Recent Repairs Rebuilt in 1921

Condition Good condition. The water level is 1' below the crest.

Repairs Needed A new steel walkway has been recently constructed and also a new chain link fence, with a lock and key around the walkway area.

EMBANKMENT

Recent Repairs _____

Condition Good condition

Repairs Needed _____

GATES

Recent Repairs _____

Condition Good condition. The gate is wide open.

Repairs Needed A new chain link fence, with a lock and key, erected around the gate house.

LEAKS

How Serious _____

DATE: _____ County Engineer

TOWN Sutton DAM NO. [illegible]

LOCATION [illegible] Rd STREAM [illegible] River

"Manchaug Pond"

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Manchaug Reservoir [illegible]

Owned by Town of Sutton Place Selectmen Use Storage & recreation

Inspected by [illegible] - Del Bornes Date [illegible] 2 19[illegible]

Type of Dam [illegible] Embankment Condition [illegible]

SPILLWAY

Flashboards in Place [illegible] Recent Repairs

Condition A new [illegible] has been [illegible] at the

Repairs Needed spillway [illegible]. The boards [illegible] are controlled by [illegible] Machine Works.

EMBANKMENT

Recent Repairs

Condition [illegible]

Repairs Needed [illegible] upstream [illegible] on account of the present low water level.)

GATES

Recent Repairs

Condition [illegible]

Repairs Needed [illegible] The gate is controlled by [illegible] Machine Works.

LEAKS

How Serious [illegible]

DATE: County Engineer

Sutton

Torrey Road

53-54

"Manchaug Reservoir

Owned by Manchaug Reservoir Corp.

Inspected by "Del" Barnes Mar. 1968

All boards on the spillway went out during the flood. The high water level was 15½" over the boards.

TOWN Sutton DAM NO. 53-04

LOCATION Torrey Rd STREAM Manchaug River

"Manchaug Pond"

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Manchaug Reservoir Corp - Water Rights

Owned by Town of Sutton (Dam) Place Selectmen Use Storage Pond & Recreation

Inspected by [illegible] Date Apr 9 196[illegible]

Type of Dam Roadway Embankment Condition Good

SPILLWAY

Flashboards in Place ______ Recent Repairs ______

Condition Good

Repairs Needed ______

EMBANKMENT

Recent Repairs ______

Condition Good

Repairs Needed ______

GATES

Recent Repairs ______

Condition Good

Repairs Needed [illegible]

LEAKS

How Serious ______

DATE: ______ County Engineer

BY RFB DATE 6-19-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. ___ OF ___

CHKD. BY ______ DATE ______ [illegible] PROJECT [illegible]

SUBJECT Manchaug [illegible] Dam, Storage Capacity

[illegible] 515.9 − 498.5 = 17.4 FT

SAY WATER SURFACE AREA ON U.S.G.S. SHEET @
ELEV 517 = WATER SURFACE @ [illegible]
ELEV 515.9 FT ∴ AREA = 349 ACRES

VOLUME = 1/3 HA = 1/3 × 17.4 × 349 = 2024 ACRE-FT

FROM [illegible] INVENTORY SHEET VOLUME = 2860 ACRE-FT

SAY VOLUME = 2500 ACRE-FT

ELEV. FT.	AREA ACRES	AVE AREA	Δ H	ΔV VOL	TOTAL VOLUME	SURCHARGE VOLUME
515.9	349				2500	
517	359	354	1.1	389	2889	389
519	377	368	2	736	3625	1125
520	386	382	1	382	4007	1507
522	406	396	2	792	4799	2299
524	426	416	2	832	5631	3131
526	446	436	2	872	6503	4003
528	466	456	2	912	7415	4915
530	486	476	2	952	8367	5867
532	506	496	2	992	9359	68[illegible]

BY SFE DATE 3-27-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 2 OF 4

CHKD. BY DATE NEGATION OF [illegible] PROJECT [illegible]

SUBJECT MANGANA Pond [illegible] H.E.T.

Area Elev 530

Read #2 23.03 Read #5 [illegible]

#1 22.74 #6 23.09

5.29 5.30

Area Elev 530 = 5.295 (91.82) = 486 Acres

BY [illegible] DATE 3-27-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 1 OF [illegible]
CHKD. BY ______ DATE ______ INSPECTION OF DAMS PROJECT [illegible]
SUBJECT [illegible]

Find Drainage Area, [illegible] Quad [illegible]

Read #2 96.65 Read #3 140.47 Ave 43.815
" #1 52.82 " #2 96.65
43.83 43.80

Worcester [illegible] Quad 1:24 000

Read #2 47.85 Read #3 49.92
" #1 45.83 " #2 47.85 Ave 2.045
2.02 2.07

Drainage Area = 43.815 (0.1437) = 6.289
2.045 (0.1433) = .293
6.58 Sq. Mi
4212 Acres

Reservoir Surface Area, Elev 517

Read #2 11.80 Read #3 15.65
" #1 08.04 " #2 11.80
3.76 3.85

Res Surface Area = 3.805 (91.82) = 349 Acres

Area Elev. 520

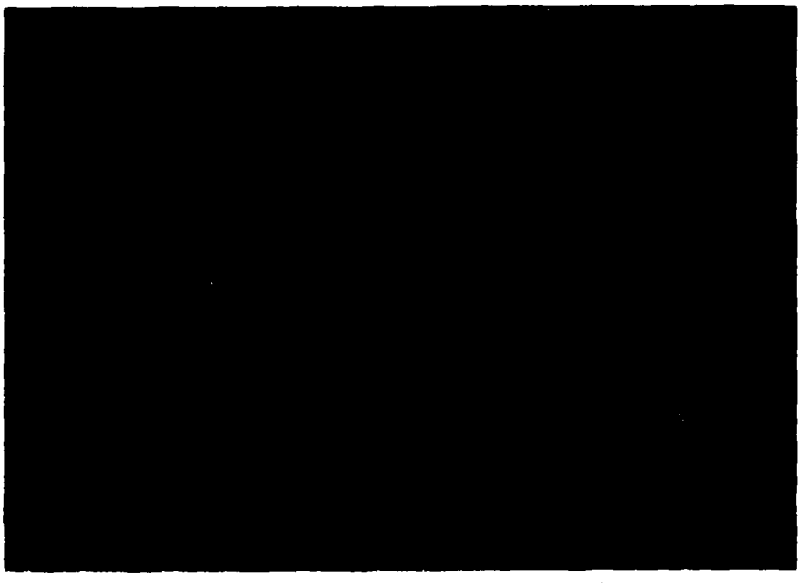
Read #2 19.82 Read #3 24.01
" #1 15.61 " #2 19.82
4.21 4.19

Area Elev 520 = 4.20 (91.83) = 386 Acres

Appendix D

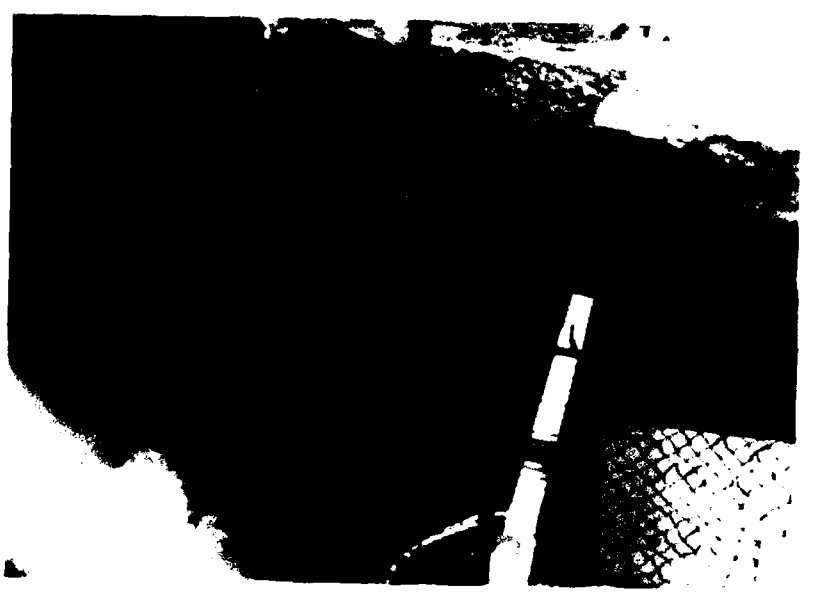
Hydrologic and Hydraulic Computations

9. Low level conduit outlet at downstream toe of dam

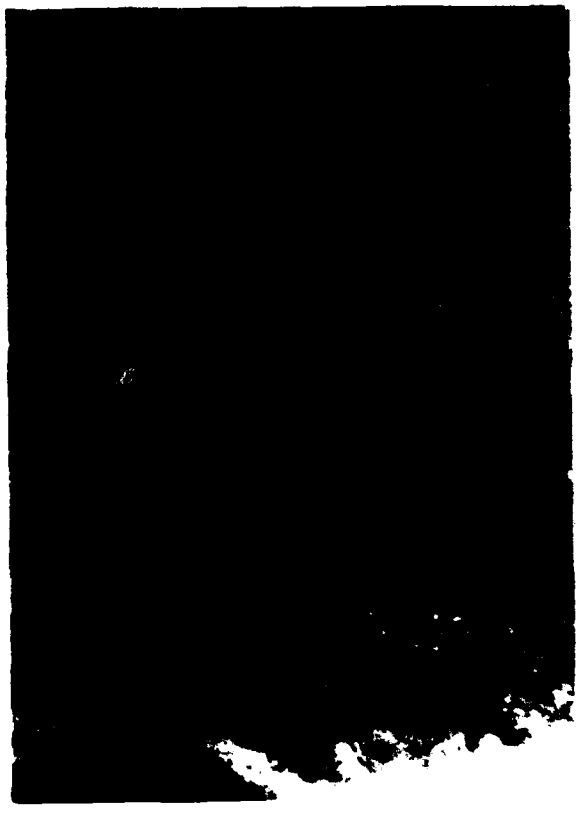


10. Downstream spillway discharge channel

7. Spillway outlet at downstream toe of dam

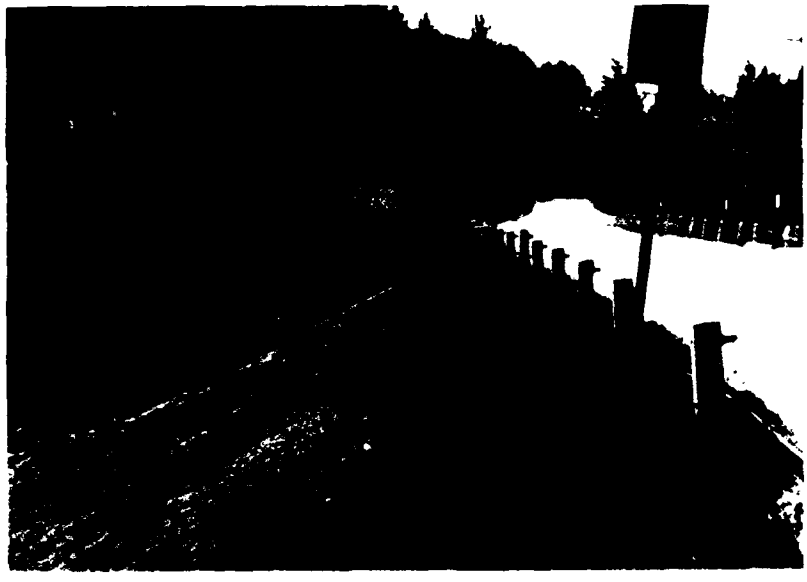


8. Spillway stoplog structure. Note seepage from right rubble masonry spillway training wall.



5. Downstream face of dam at spillway outlet

6. Spillway entrance (background) and outlet conduit control mechanism (far background).

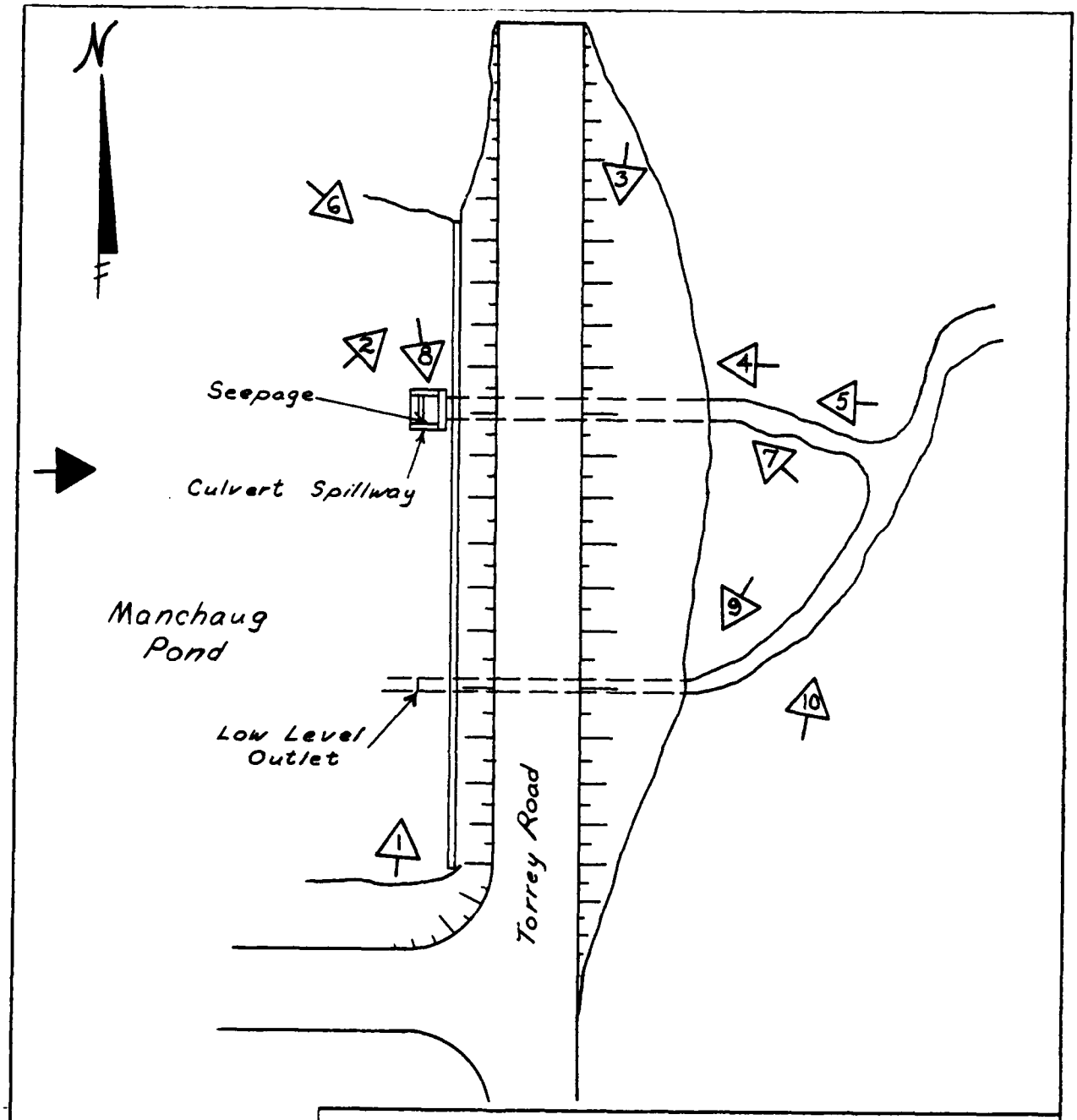


3. Downstream slope from left abutment

4. Drain pipe at downstream toe just left of spillway outlet

1. Upstream rubble masonry wall

2. Typical small void in upstream rubble wall



OVERVIEW PHOTO →

APPENDIX 'C' PHOTOS ▷

LOUIS BERGER & ASSOC., INC WELLESLEY, MASS. ARCHITECT · ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

MANCHAUG POND DAM

SKETCH PLAN SHOWING LOCATION & ORIENTATION OF PHOTOS

STATE - MA

SCALE NOT TO SCALE

DATE

Appendix C

Photographs

TOWN SUTTON DAM NO. 50-34

LOCATION _____ STREAM _____

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by _____ Place _____ Use _____

Inspected by [illegible] Date MARCH 27 1960

Type of Dam _____ Condition [illegible]

SPILLWAY

Flashboards in Place NO BOARDS Recent Repairs _____

Condition [illegible]

Repairs Needed _____

EMBANKMENT

Recent Repairs _____

Condition _____

Repairs Needed _____

GATES

Recent Repairs [illegible]

Condition _____

Repairs Needed _____

LEAKS

How Serious _____

DATE: _____

County Engineer

TOWN Sutton DAM NO. 50-24

LOCATION Terry Rd STREAM Manchaug River
"Manchaug Pond"

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Manchaug Reservoir Corp c/o Delwyn K. Barnes, Manager Place Whitinsville Water Co. 44 Lake St. Whitinsville Use Storage Pond

Inspected by WOL Date Mar 13 1969

Type of Dam Highway Embankment Condition Good
Flood Patrol

SPILLWAY

Flashboards in Place _____ Recent Repairs _____

Condition Good

Repairs Needed _____

EMBANKMENT

Recent Repairs The water is about 12" below the crest

Condition _____

Repairs Needed _____

GATES

Recent Repairs _____

Condition The gate is wide open

Repairs Needed _____

LEAKS

How Serious _____

DATE: _____ County Engineer

B-24

TOWN Sutton DAM NO. 52-24

LOCATION Manchaug Road STREAM Mill Brook

"Manchaug Pond"

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Manchaug Reservoir Co. Place Whitinsville Use Storage Reservoir

Inspected by W.O.L Date Jan 31, 1963

Type of Dam Highway Embankment Condition good

SPILLWAY

Flashboards in Place All boards removed Recent Repairs

Condition 1" of water over the crest

Repairs Needed

EMBANKMENT

Recent Repairs

Condition good

Repairs Needed

GATES

Recent Repairs

Conditions Gate in good open

Repairs Needed

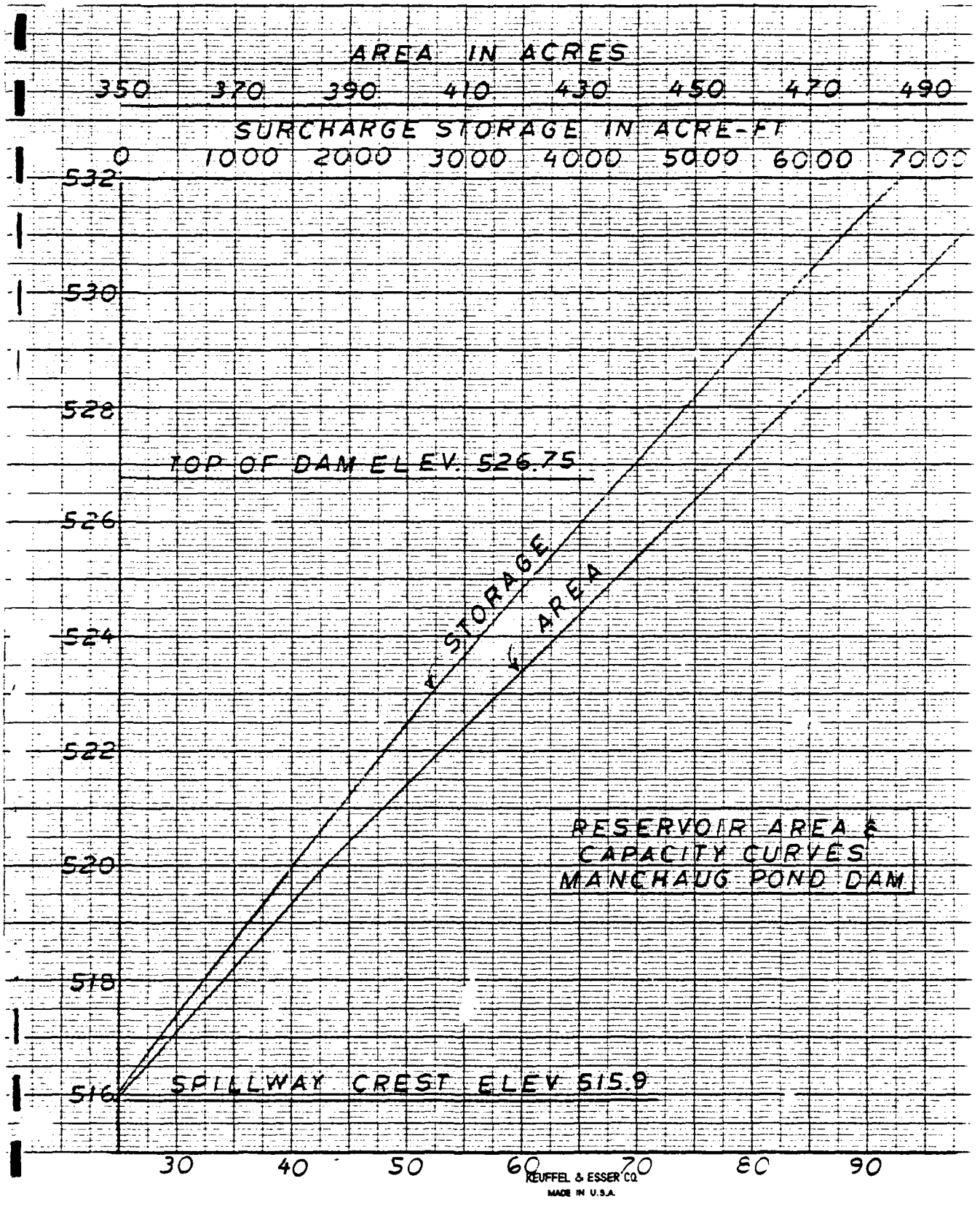
LEAKS

How Serious None visible

DATE:

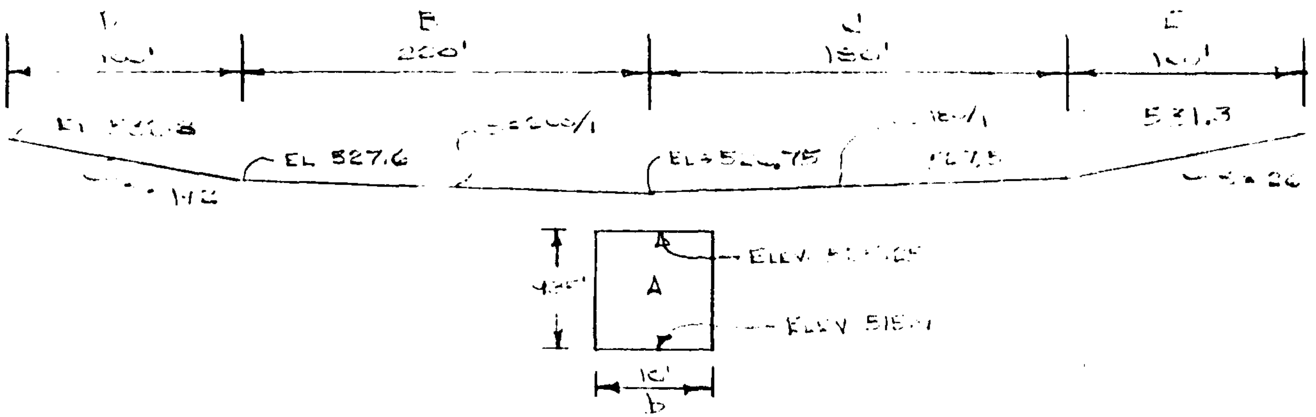
County Engineer

B-23


AREA IN ACRES
350 370 390 410 430 450 470 490
SURCHARGE STORAGE IN ACRE-FT
0 1000 2000 3000 4000 5000 6000 7000
532
530
528
TOP OF DAM ELEV. 526.75
526
524
522
520
518
516
STORAGE
AREA
SPILLWAY CREST ELEV 515.9
30 40 50 60 70 80 90
RESERVOIR AREA & CAPACITY CURVES
MANCHAUG POND DAM
KEUFFEL & ESSER CO.
MADE IN U.S.A.

LOUIS BERGER & ASSOCIATES INC.

BY [illegible] DATE [illegible]
CHKD. BY ______ DATE ______
SUBJECT [illegible]
SHEET NO. ____ OF ____
PROJECT [illegible]



ELEV FT	* A HW/D	* A Q/b	* A Q	B, C=2.8 H	B, C=2.8 L	B, C=2.8 Q	C, C=2.6 H	C, C=2.6 L	C, C=2.6 Q	D, C=2.5 H	D, C=2.5 L	D, C=2.5 Q
514	[illegible]	13.0	130	0	–	0	0		0	0	–	[illegible]
521	[illegible]	24	290	↕	–	0	↕		0	↕		
52[illegible]	0.76	47	470	↕	–	0	↕			↕	–	
[illegible]	0.97	68	680	↕	–	[illegible]	↕			↕	–	
524.75	1.16	88	880	0	–	[illegible]				↕		
527	1.11	91	910	.125	100	12	.10	90	11	↕	–	[illegible]
527.5	1.24	96	960	.375	200	129	.38	180	118	0	–	[illegible]
528	1.2[illegible]	101	1010	.83	200	466	.68	↓	416	.2	0	[illegible]
[illegible]	1.3[illegible]	106	1060	1.33	↓	945	1.38	↓	817	.45	17	[illegible]
[illegible]	1.40	111	1110	1.83	↓	1525	1.88	↓	1249	.70	[illegible]	[illegible]
[illegible]	1.4[illegible]	116	1160	2.33	↓	2140	2.38	↓	1850	.95	[illegible]	[illegible]
[illegible]	1.51	121	1210	2.83	↓	2933	2.88	↓	2461	1.20	46	151
[illegible]	[illegible]	126	1260	3.33	↓	3742	3.38	↓	3152	1.45	[illegible]	244
5[illegible]1	1.[illegible]	1[illegible]	13[illegible]	3.83	↓	4617	3.88	↓	[illegible]	1.70	[illegible]	[illegible]

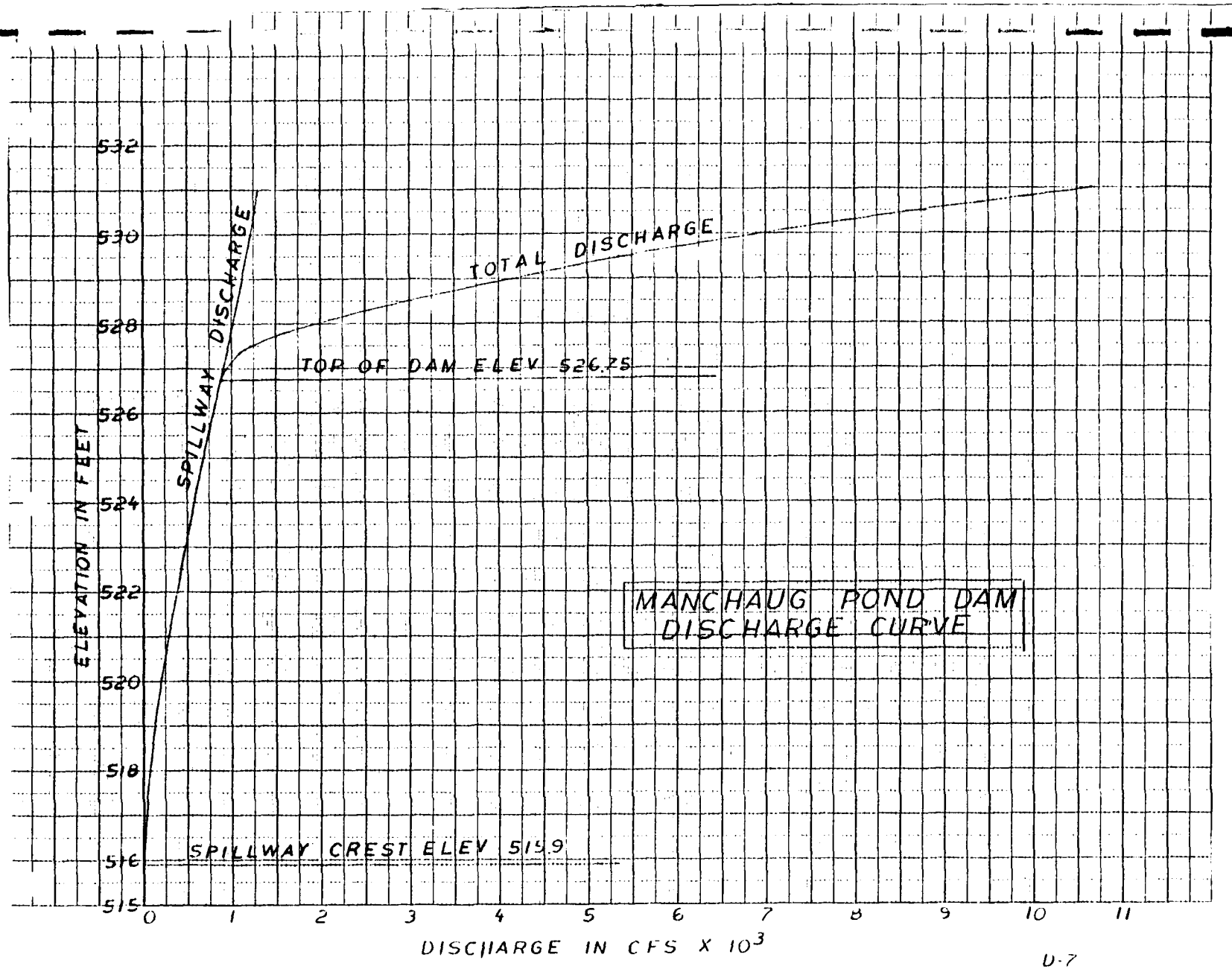
* From U.S. Department of [illegible]
[illegible] Engineering Circular, [illegible]
Chart No. 1

BY REE DATE 6-7-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 2 OF

CHKD. BY DATE

SUBJECT MAIN [illegible] PROJECT N-[illegible]

ELEV FT	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
514	0	—	0	130
521	↑	—	0	290
528		—	0	470
529.7		—	0	530
528.75		—	0	530
527		—	0	935
527.5	0	—	0	1205
526	.25	13	4	1400
524.5	.5	24	33	2560
523	.75	34	68	4035
524.5	1.0	59	132	5415
525	1.25	66	192	6885
526.5	1.50	74	362	8740
528	1.75	92	592	10660



MANCHAUG POND DAM
DISCHARGE CURVE

BY RFB DATE 4-3-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 1 OF 2

CHKD. BY ____ DATE ____ INSPECTION OF DAMS PROJECT W-1[illegible]

SUBJECT MANCHAUG POND [illegible] [illegible] H[illegible]

[illegible] AREA, [illegible] = [illegible]
[illegible] < 25% D.A.

LENGTH [illegible] WATER [illegible], L = 21,200 FT
L = 4.02 MI

ELEV DIFFERENCE = 675 - 517 = 158 FT

∴ SLOPE = $\frac{158}{4.02}$ = 39 FT/MILE ∴ $\sqrt{S}$ = 6.27

$\left(\frac{L L_{ca}}{\sqrt{S}}\right)^{.33} = \left(\frac{4.02 \times 4.02}{6.27 \times 2}\right)^{.33} = 1.09$

$LAG = K\left(\frac{L L_{ca}}{\sqrt{S}}\right)^{.33} = 1.09K$

ASSUME K = 5.0 REFER TO "CURVE B" MOUNTAINOUS REGION MIXED TERRAIN, B OR REL

LAG = 1.09K = 1.09(5) = 5.45

$T_p = 0.41D + 0.82\,LAG$, WHERE D = 1.0 HR

$T_p = 0.41(1) + 0.82(5.45)$

$T_p = 0.41 + 4.47 = 4.88$ HRS

CHECK VELOCITY $T_c = \frac{T_p - 0.5D}{0.6}$

$T_c = \frac{4.88 - 0.5}{0.6} = 7.3$ HRS

$V = \frac{21{,}200}{7.3 \times 3600} = 0.81$ FT/SEC O.K.

BY RFB DATE 4-4-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 2 OF 2

CHKD. BY ______ DATE ______ INSPECTION OF DAMS PROJECT W-193

SUBJECT Manchaug Pond Dam, [illegible]

$T_r = 1.67\,T_p = 1.67(4.88) = 8.15$ hr

$T_b = T_p + T_r = 4.88 + 8.15 = 13.03$ hr

q_p = Peak rate in cfs

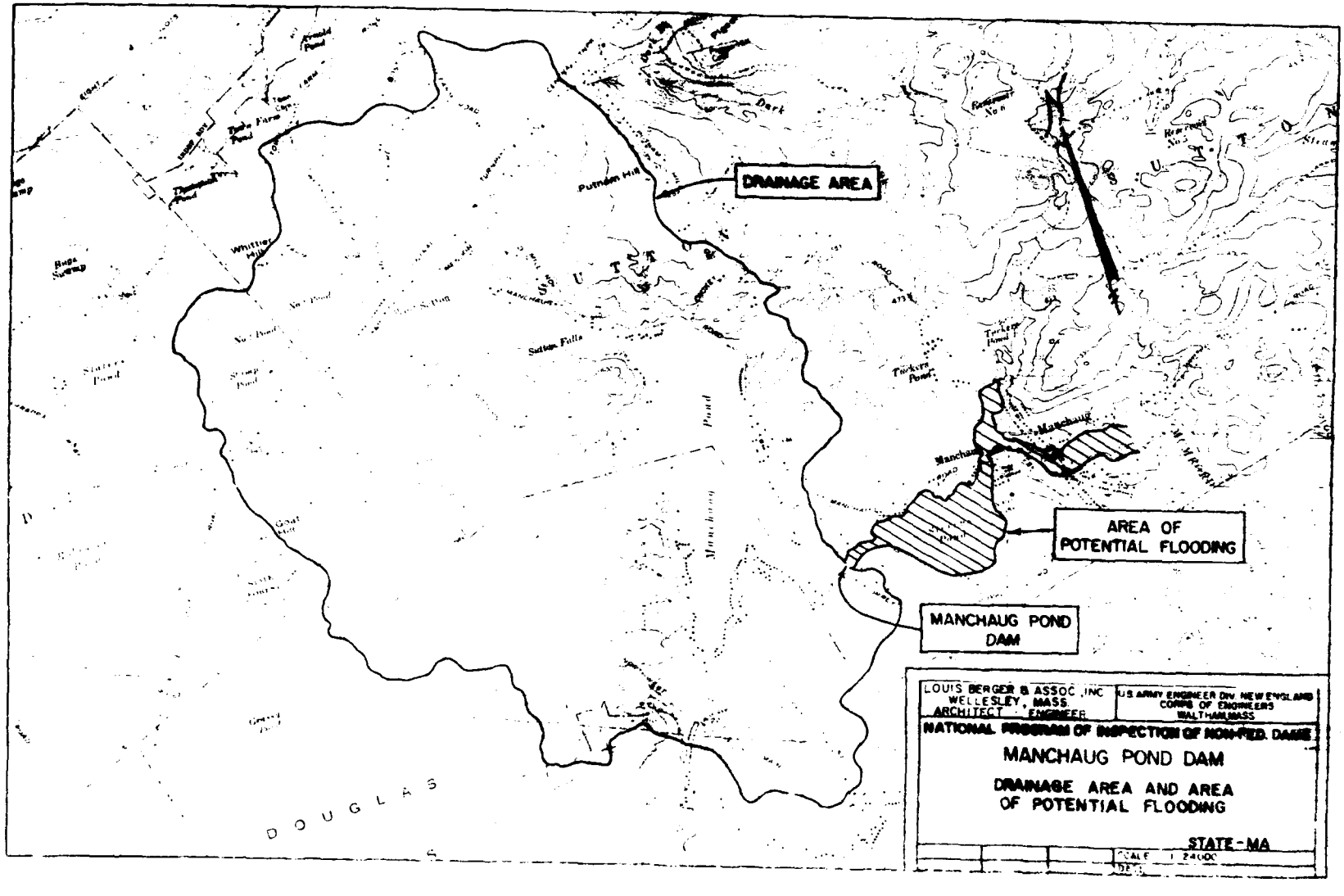
$$q_p = \frac{484\,A\,Q}{T_p}$$

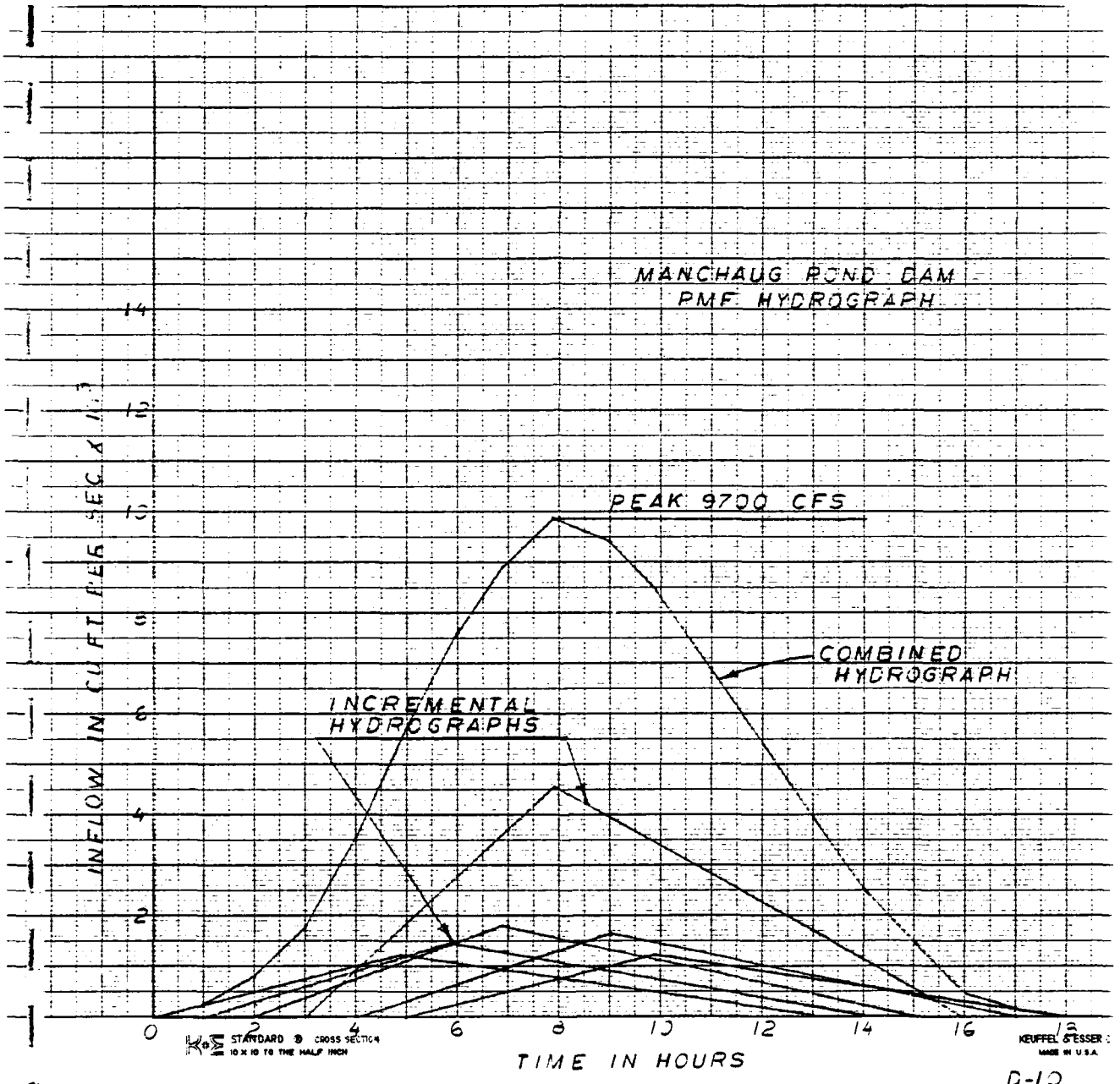
A = Drainage Area
Q = Runoff in inches

$$q_p = \frac{484(6.58)(1)}{4.88} = 653 \text{ cfs}$$

PMP = Probable Maximum Precipitation
= 23.5 (0.8) = 18.8" for Sutton, Mass
= 18.4" considering infiltration for overland flow

Time (Hours)	Rainfall * %	Rainfall Inches	q_p cfs	TIME Begin	TIME Peak	TIME End
0.0	–					
1.0	10	1.84	1201	0	4.88	13.03
2.0	12	2.21	1443	1.0	5.88	14.03
3.0	15	2.76	1802	2.0	6.88	15.03
4.0	38	6.99	4564	3.0	7.88	16.03
5.0	14	2.58	1685	4.0	8.88	17.03
6.0	11	2.02	1319	5.0	9.88	18.03


DRAINAGE AREA
AREA OF POTENTIAL FLOODING
MANCHAUG POND DAM
SUTTON
DOUGLAS
LOUIS BERGER & ASSOC., INC.
WELLESLEY, MASS.
ARCHITECT - ENGINEER
U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
MANCHAUG POND DAM
DRAINAGE AREA AND AREA
OF POTENTIAL FLOODING
STATE - MA
SCALE 1:24000


MANCHAUG POND DAM
PMF HYDROGRAPH
PEAK 9700 CFS
COMBINED HYDROGRAPH
INCREMENTAL HYDROGRAPHS
INFLOW IN CUBIC FEET PER SEC
0
2
4
6
8
10
12
14
16
18
TIME IN HOURS
KEUFFEL & ESSER CO.
MADE IN U.S.A.

D-10

BY RFB DATE 6-20-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 1 OF 1

CHKD. BY DATE Inspection of Dams PROJECT W-155

SUBJECT Maximum Pan Coal, Reservoir Routing

Drainage Area = 6.58 sq.mi = 4212 Acres

Size Classification - Intermediate

Maximum Storage = 6850 Acre-ft
Height = 28 ft

Hazard Classification = High
OCE Guidelines, Use PMF

From Below Hydrograph, PMF = 9,700 cfs

Step 1a: Q_{p1} = 9,700 cfs

Step 2a: Elev = 530.75 ft

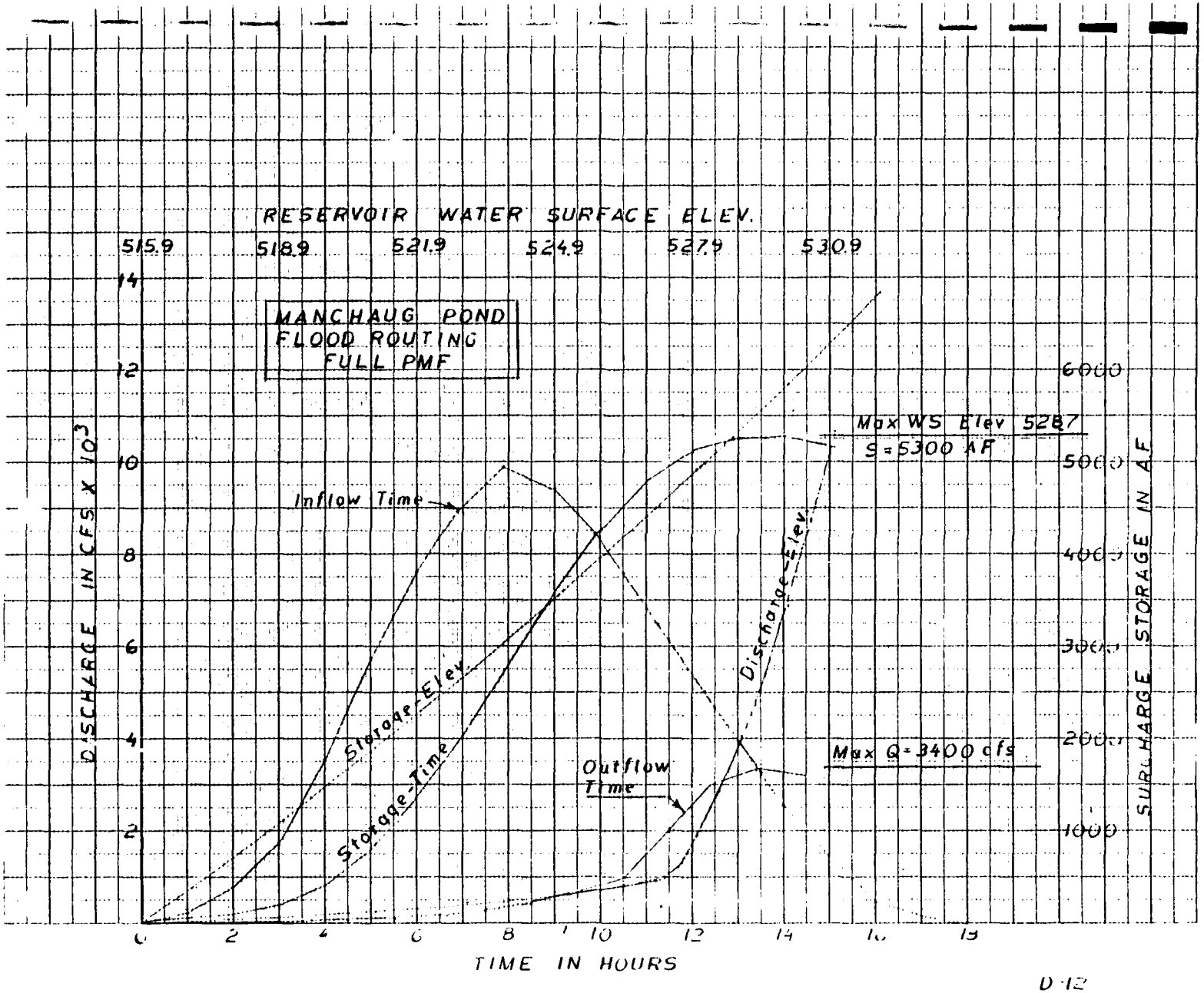
Step 2b: Surcharge Volume = 68.50 Acre-ft

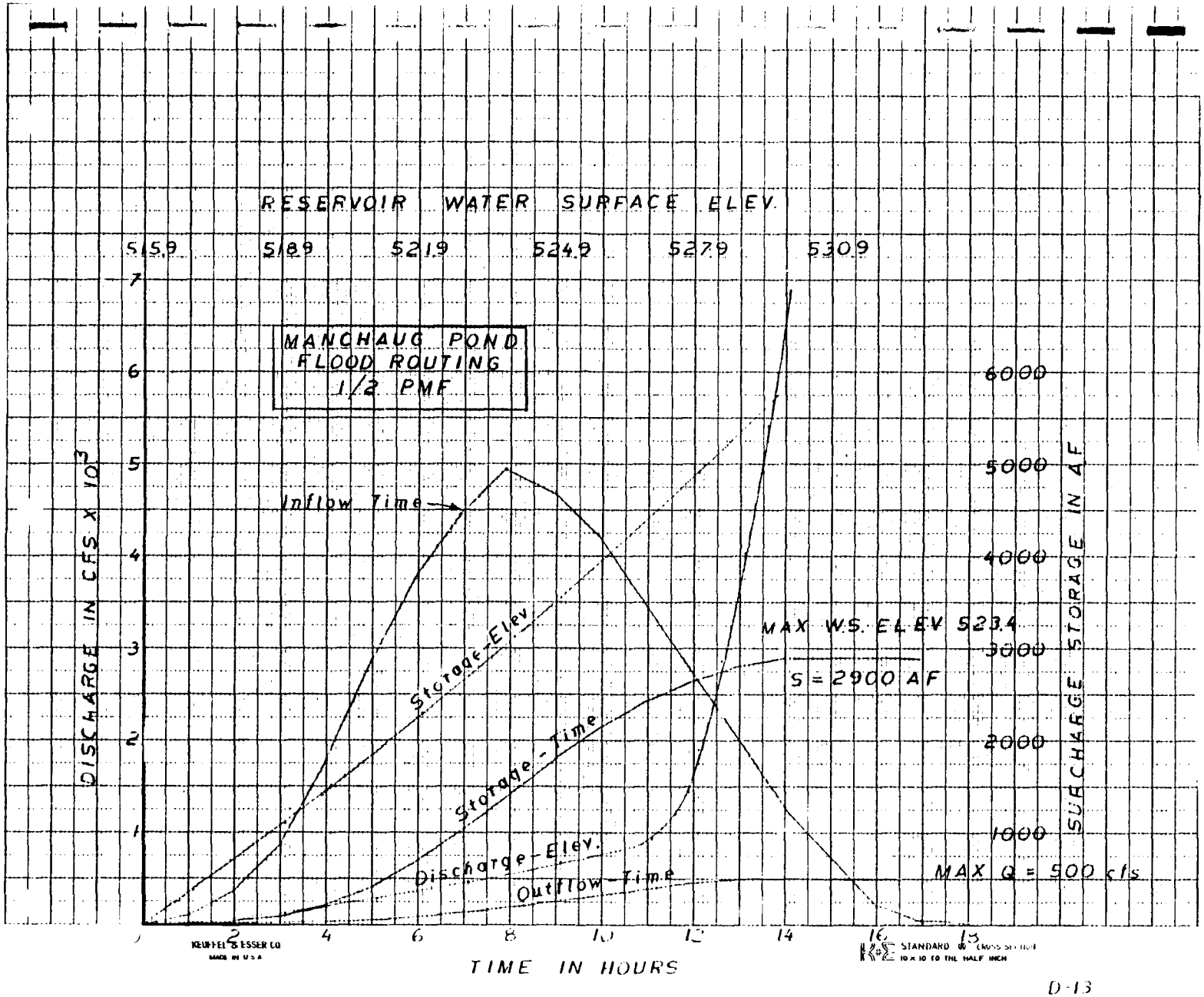
$$\text{Incus Runoff} = \frac{6850 \text{ Acre-ft}}{4212 \text{ Acres}} \times 12 \text{ in/ft} = 19.51 \text{ in}$$

Step 2c: $Q_{p2} = 9{,}700 \times \left(1 - \frac{19.5}{19}\right)$

$Q_{p2} < 0$

Use Graphic Solution


RESERVOIR WATER SURFACE ELEV.
515.9
518.9
521.9
524.9
527.9
530.9
MANCHAUG POND
FLOOD ROUTING
FULL PMF
DISCHARGE IN CFS X 10³
SURCHARGE STORAGE IN AF
Max WS Elev 528.7
S = 5300 AF
Max Q = 3400 cfs
Inflow Time
Outflow Time
Storage-Elev.
Storage-Time
Discharge-Elev.
TIME IN HOURS


RESERVOIR WATER SURFACE ELEV.
5159
5189
5219
5249
5279
5309
MANCHAUG POND
FLOOD ROUTING
1/2 PMF
DISCHARGE IN CFS X 10³
SURCHARGE STORAGE IN AF
Inflow Time
Storage-Elev.
Storage-Time
Discharge-Elev.
Outflow-Time
MAX W.S. ELEV 523.4
S = 2900 AF
MAX Q = 500 cfs
TIME IN HOURS
KEUFFEL & ESSER CO.
MADE IN U.S.A.
STANDARD 10 CROSS SECTION
10 X 10 TO THE HALF INCH

BY RFB DATE 6-24-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. ____ OF ____

CHKD. BY ____ DATE ____ PROJECT ____

SUBJECT MANDALL POND DAM, FAILURE ANALYSIS

STA 1 [illegible] ELEV. [illegible]
WATER AT CREST OF EMERGENCY SPILLWAY
STORAGE = 6,830 ACRE-FT

HEIGHT = 28.0'
MEAN CREST LENGTH = 240'

W = 40% (240) = 96'

STA 1A PEAK FAILURE OUTFLOW

$Q_p = 8/27\ W\sqrt{g}\ Y_o^{3/2}$

$Q_{p1} = 1.68\ (96)(29.25)^{3/2}$

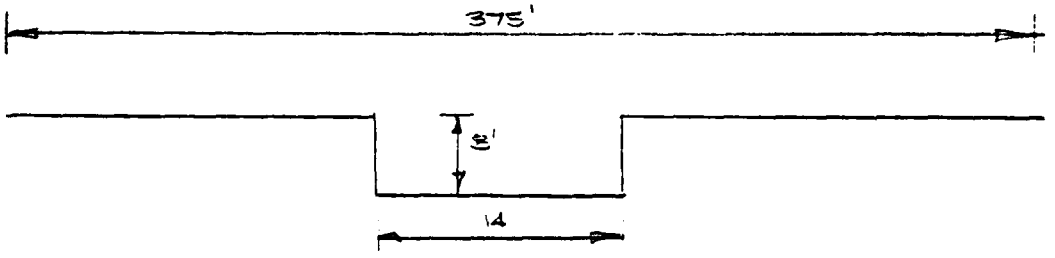
$Q_{p1} = 24,200$ CFS

ADD SPILLWAY FLOW = $Q_{spillway}$ = 900

Q_{p1} TOTAL = 24,200 + 900

SAY Q_{p1} = 25,100 CFS

NO SIGNIFICANT STORAGE BETWEEN MANDALL POND & STEVENS POND



STEVENS POND DAM

BY [illegible] DATE 6-24-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 2 OF [illegible]

CHKD. BY ______ DATE ______ INSPECTION OF DAMS PROJECT W-1[illegible]

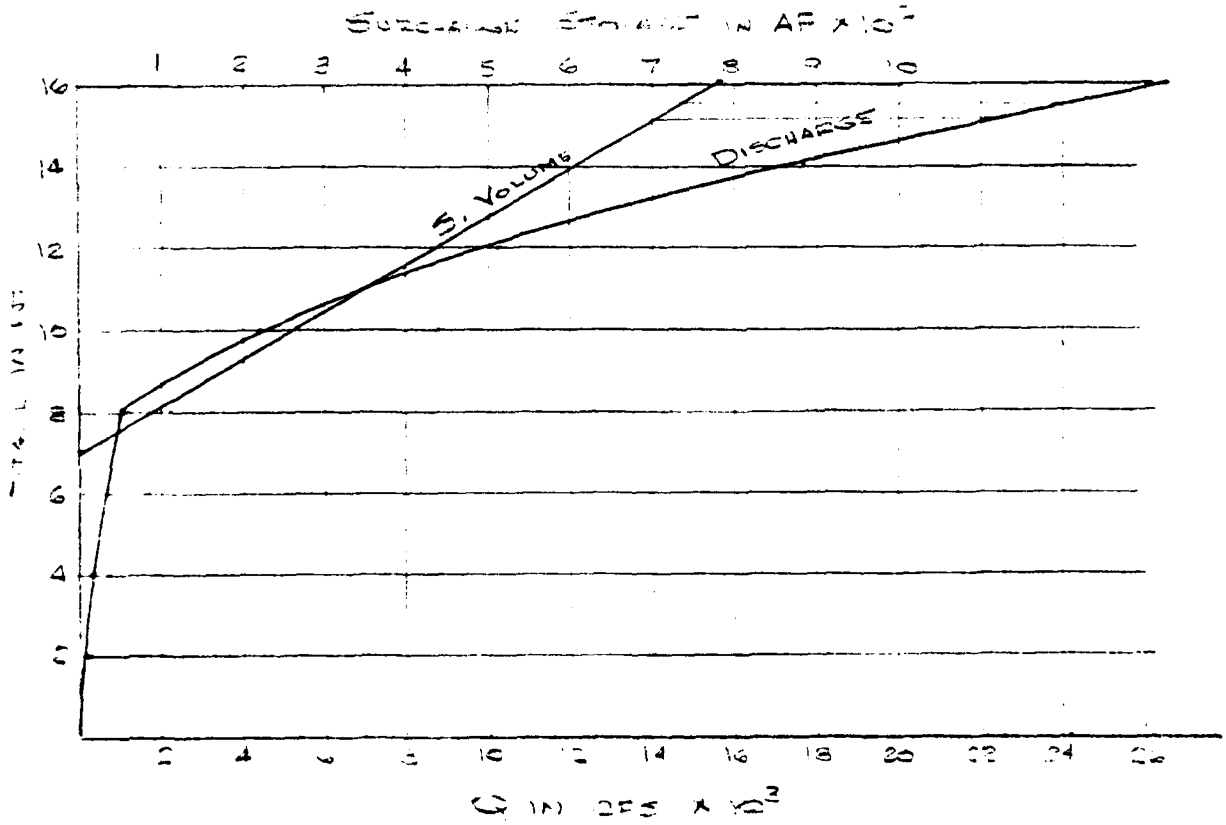
SUBJECT [illegible] [illegible] DAM, FAILURE [illegible] #2

STAGE	H	C	L	Q	H	C	L	Q	ΣQ
2	2	3.2	14	105	0	2.9	361	0	105
4	4			360	0			0	360
6	6			[illegible]	0			0	660
8	8			11[illegible]0	0			0	11[illegible]0
10	10			1420	[illegible]			2960	4380
12	12			1860	4			8375	10270
14	14	3.2		2350	6			[illegible]	[illegible]700
16	16	3.2	14	2870	8	2.9	361	[illegible]	[illegible]

COMPUTE SURCHARGE VOLUME ABOVE STAGE 7 FT

AREA @ STAGE 7 FT = 72 ACRES
AREA @ STAGE 16 FT = 101 ACRES

$\Delta V = \left(\frac{101+72}{2}\right)(9) = 779$ A.F.



For Q = 25,100, Stage = 15.5, V_1 = 730 AF

$$Q_{p_2(TOTAL)} = 25{,}100\left(1 - \frac{730}{6950}\right)$$

$$= 22{,}425$$

For Q = 22,400, Stage = 15.1, V_1 = 700

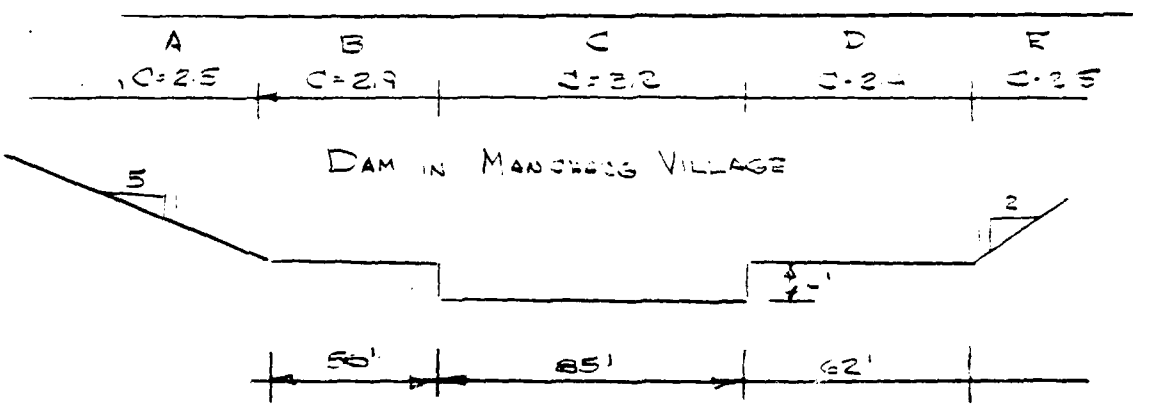
$$V_{AVE} = \frac{730 + 700}{2} = 715$$

$$Q_{p_2} = 25{,}100\left(1 - \frac{715}{6950}\right) =$$

$$Q_{p_2} = 22{,}500$$

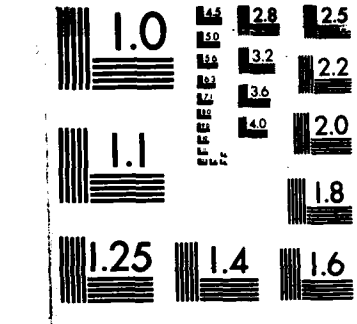
Storage Pond Outflow

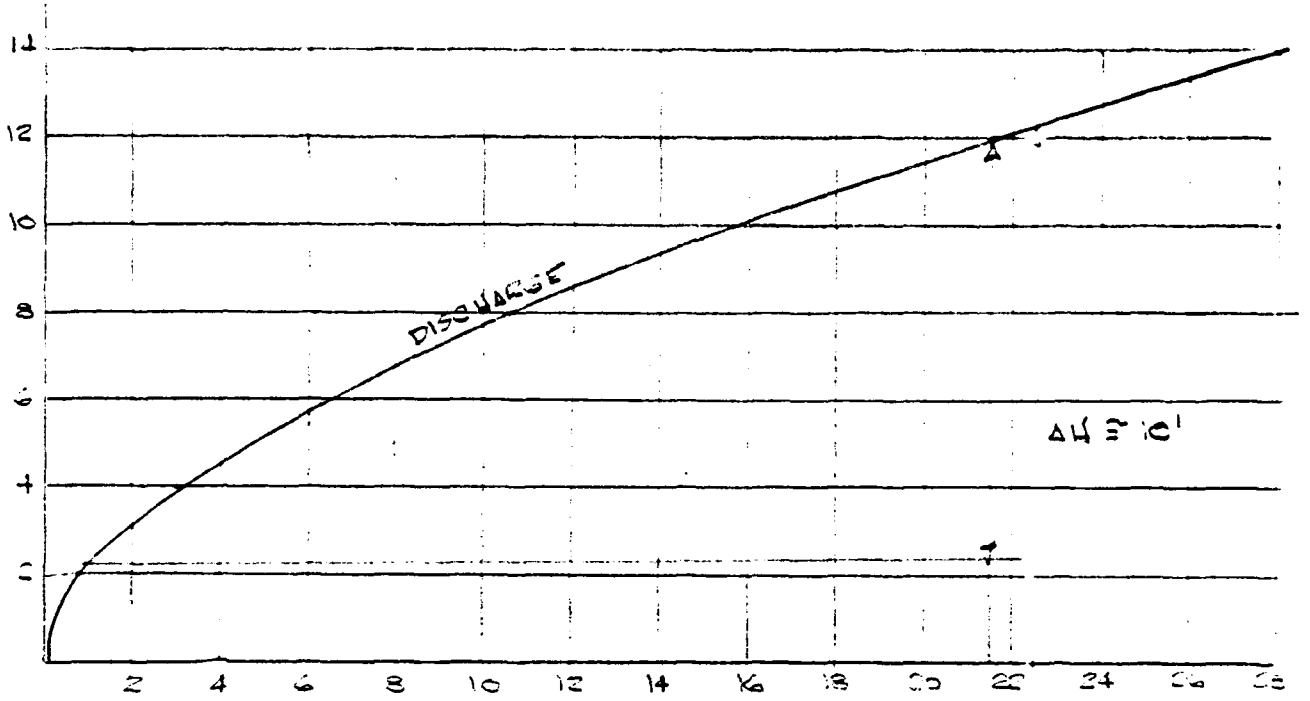
Q = 22,500, Stage = 15.5, ΔH = 7.5 ft



	A			B+D			C			D		
H	L	Q	H	L	Q	H	L	Q	H	L	Q	SQ
0	-	0	0	102	0	2	85	770	0	-	0	800
1	5	10	2		800	4		2200	1	2	10	2400
2	15	200	6		4900	5		6150	3	6	100	10700
3	25	700	10		9350	12		11300	5	8	300	21600
6	30	1100	12		12300	14		14200	6	10	400	28000

AD A155 785 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 2/2
MANCHAUG POND DAM MA..(U) CORPS OF ENGINEERS WALTHAM MA
NEW ENGLAND DIV JUL 80
UNCLASSIFIED F/G 13/13 NL





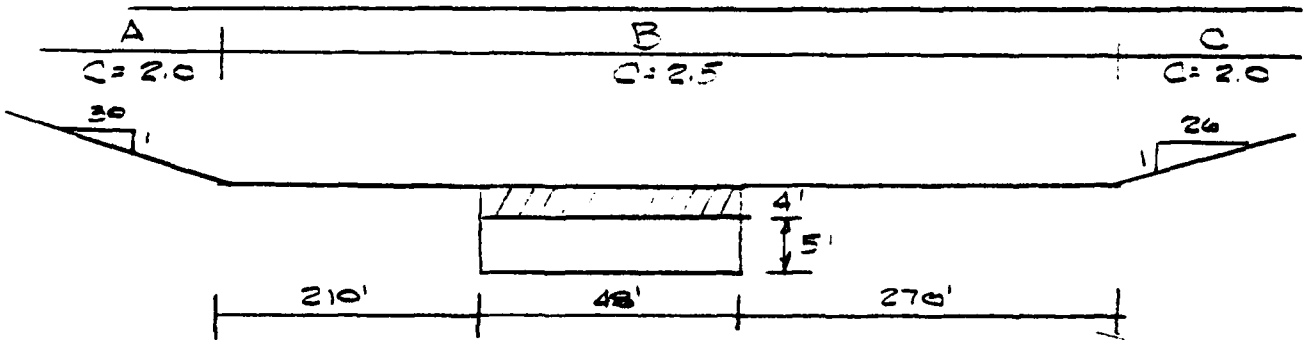
VOLUME OF STORAGE BETWEEN STEVENS POND &

$V_1 = 30 \text{ ACRES} \times 10 \text{ FT} = 300 \text{ A.F.}$

$$Q_{P_2} = 22{,}500 \left(1 - \frac{300}{6650}\right)$$

$Q_{P_2} = 21{,}500$ CFS @ JUNCTION OF MANCHAUG

$\Delta H \cong 10$ FT OVER DAM



MANCHAUG ROAD BRIDGE

BY RFB DATE 6-27-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 5 OF 9
CHKD. BY _____ DATE _____ INSPECTION OF DAMS PROJECT W-185
SUBJECT MANCHAUG POND DAM FAILURE ANALYSIS

BRIDGE OPENING (ASSUME NO JOINTS)

H	HW/D	Q/3	Q	OVER ROAD H
3	0.6	13	620	-
6	1.2	36	1730	-
9	1.8	55	2640	-
12	2.4	70	3360	3
15	3.0	92	5940	6

ASSUME WEIR FLOW OVER ROAD

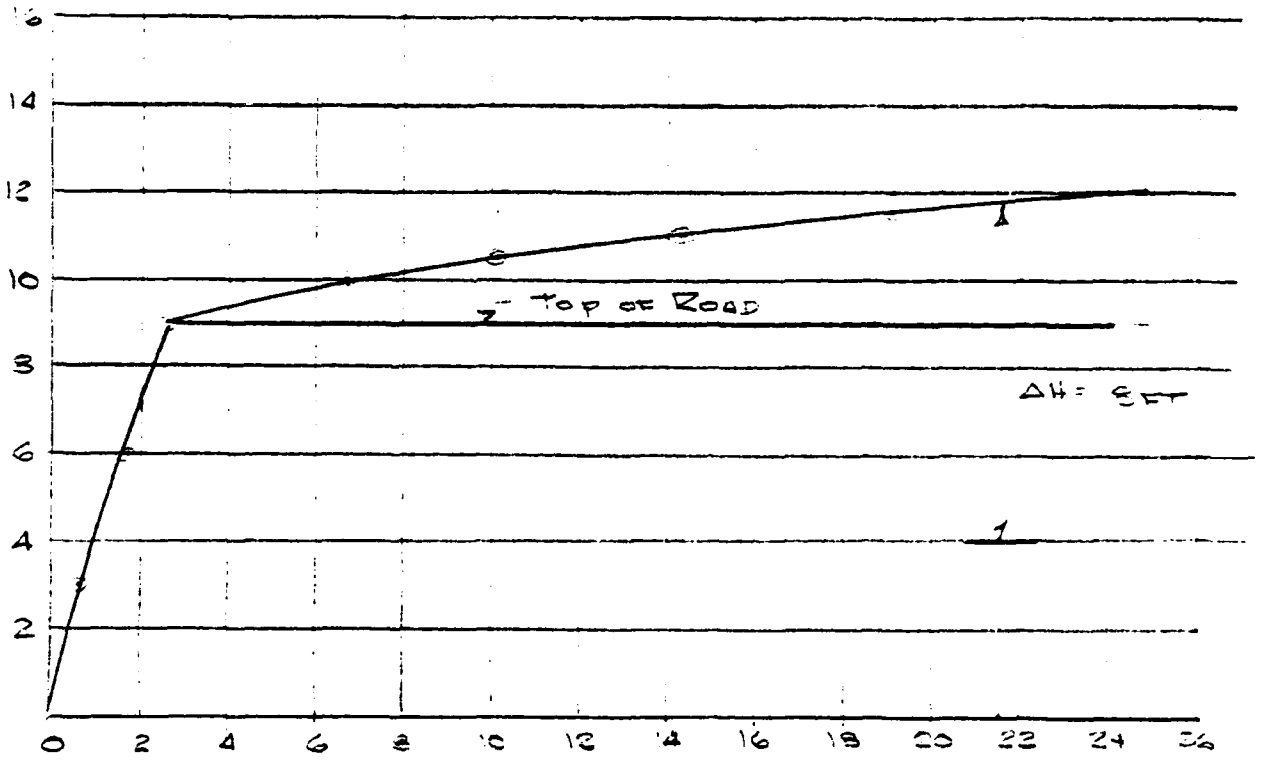
A H	A L	A Q	B H	B L	B Q	J H	J L	J Q	ΣQ
1	30	60	2	523	3730	1	24	50	3840
1.5	45	160	3		6860	1.5	34	140	7160
2	60	340	4		10600	2	52	300	11240
2.5	75	590	5		14760	2.5	65	510	15860
3.0	90	930	6		19400	3.0	78	810	21100

H ABOVE STREAM	ΣQ	H OVER ROAD
3	600	-
6	1700	-
9	2600	-
12		3
15		6

BY REB DATE 6-27-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 6 OF 6

CHKD. BY ____ DATE ____ INSPECTION OF DAMS PROJECT W-136

SUBJECT MANCHAC POINT DAM, FLOODING ESTIMATES



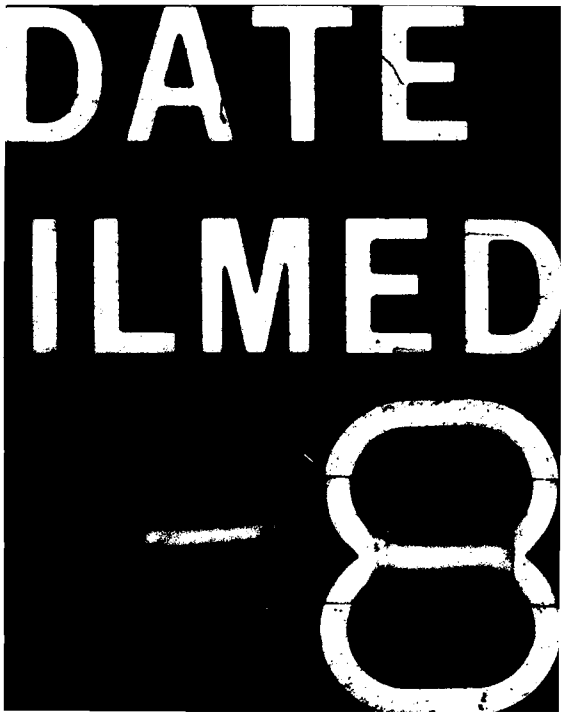
ESTIMATE OF FLOODING

MILL - 5 TO 6 FT
FIRE STATION - 5 FT
LIBRARY 5 FT
POST OFFICE 1 FT
BUILDING 1 FT
10 HOUSES 3 FT

Appendix E

Information as Contained in the National Inventory of Dams

NOT AVAILABLE AT THIS TIME


DATE
ILMED
-8